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CONDITIONS AND PROSPECTS IN THE AMERICAN IRON INDUSTRY.

By Edwin C. Eckel.

Late geologist in charge of investigations of iron ores and structural materials, U. S. Geological Survey.

THE year which recently closed opened with superficially brilliant prospects, but with underlying conditions of serious financial stress. For a time these threatening conditions were masked by the continuation of previous industrial activity, and it seemed as though the crisis might be postponed if not entirely avoided. By the middle of the year, however, the tension had greatly increased, and it needed little to bring about a crash. This was afforded in October by the uncovering of some remarkable innovations in the business methods of certain New York banks, and by the end of that month financial and industrial activity was almost completely suspended.

Though dragged down in the fall of the other industries, American iron and steel producers can be acquitted of any share of the blame. The expansion of iron and steel manufacture during the past few years has been rapid, and the prices of the products have at times escaped effective control. But in general the management of the iron industry has been conservative and few weak spots in the iron trade were revealed when the panic arrived. In these respects it affords a marked and pleasant contrast to the copper trade, where a danger spot had been created in the American industrial situation.

The course of the iron trade during 1907 was so directly affected by the financial events of the year, that it would be difficult to discuss them intelligently without briefly reviewing this financial history.

Financial History of the Year.

It has been said that 1907 opened with apparently brilliant prospects in all lines of trade. Mills and factories were running overtime in a vain attempt to catch up with accumulated orders, merchants reported unprecedented business, and the farming population had just received record prices for record crops. Underlying all this, however, was serious financial tension, international in its scope. During the years immediately preceding, excessive demands had been made upon the world's capital. Funds in unexampled amounts had been withdrawn for new railway construction in the United States. Two costly wars had been financed, while an immense amount of fixed capital had been destroyed by fire and earthquake. Real-estate and mining speculation had exacted heavy toll, particularly from the smaller investors.

With such conditions as these existing, it was evident that extreme conservatism and general confidence, would be required if serious disaster was to be avoided. Unfortunately conservatism was lacking in some high financial quarters, while public confidence had been gradually undermined. There had been unpleasant revelations as to the business ethics of prominent financiers, there had been story after story—some true but mostly false—of graft and rottenness in American business institutions. This sort of thing had gone so far that a large and vociferous section of the people could see no remedy but the wholesale nationalization of the more important industries. All this combined to make capital timorous as to further investments, and apprehensive as to the safety of those in hand.

It is perfectly true that reform was urgently needed in some of the methods of high finance, and that the unforeseen increase of corporate power demanded means of regulation not provided by earlier statutes. Few would dispute these statements, and no honest man could have the slightest objection to such reform or regulation if carried out in a fair and reasonable manner. Early in 1907, however, radical legislative and judicial action, particularly in the southern and western States, gave rise to the general feeling that the new movement would assume a punitive rather than a corrective character, and that the status of existing investments was endangered. It became impossible to float new issues of railroad bonds or notes except at prohibitive rates of interest, and even municipal securities of undoubted standing could not be satisfactorily disposed of. The result was that expansion of business and new construction were effectively checked by a combination of scarcity of money and lack of confidence.

It was at a time like this, when all conditions suggested that extreme conservatism was desirable everywhere, that the industrial world witnessed with pained interest an attempt to market an important product at prices far above its real value. The general business activity of 1905 and 1906 had resulted in a steady and increasing demand for copper. Eighteen cents a pound for copper meant profits for all the copper mines in the country, and large profits for many of them, and at this price there was no lack of demand. Certain important copper interests, however, had come to the conclusion that consumers could be forced to pay any price for the metal. Disregarding the strained financial situation, and forgetting an earlier painful experience in the same line, the nominal price of copper was advanced steadily until it reached twenty-six cents a pound. In spite of the fact that buying stopped early in the year, the high-level prices were maintained until July, and mines and smelters were pushed to their fullest capacity. The result was the accumulation of an enormous stock of unsold copper, and this finally led to a series of sharp breaks in copper prices which did not terminate until, in October, copper sold at less than twelve cents a pound. Then, and not till then, it was decided to restrict production, a step which might better have been taken in April.

From the very beginning of the year, securities of all kinds had sagged steadily in value, their downward course being marked by three particularly sudden breaks in March, August, and October respectively. The two earlier collapses in stocks were not accompanied or followed by serious industrial changes. The October collapse, however, with its banking failures and money stringency, caused even the most optimistic to realize that prosperity had passed for a time, and that a period of severe industrial depression was at hand. Business of all kinds fell off with remarkable suddenness, and the great manufacturing industries were as usual affected first and most markedly.

The Iron Trade in 1907.

The iron industry shared with other lines of business both the earlier prosperity and the later depression. For the first nine months of the year the furnaces and mills were operated at their fullest capacity, and the earnings of the iron and steel companies were record-breaking. Prices softened somewhat about the middle of the year, and new orders were less pressing, but at the close of September the prospects seemed good that the iron output of the year would be very largely in excess of the production of 1906, itself a record year. In the last quarter of the year, however, the collapse came.

New orders did not lessen gradually—they simply stopped suddenly and completely; and the only thing that held prices fairly steady was an equally sudden and complete shut-down of furnaces and mills.

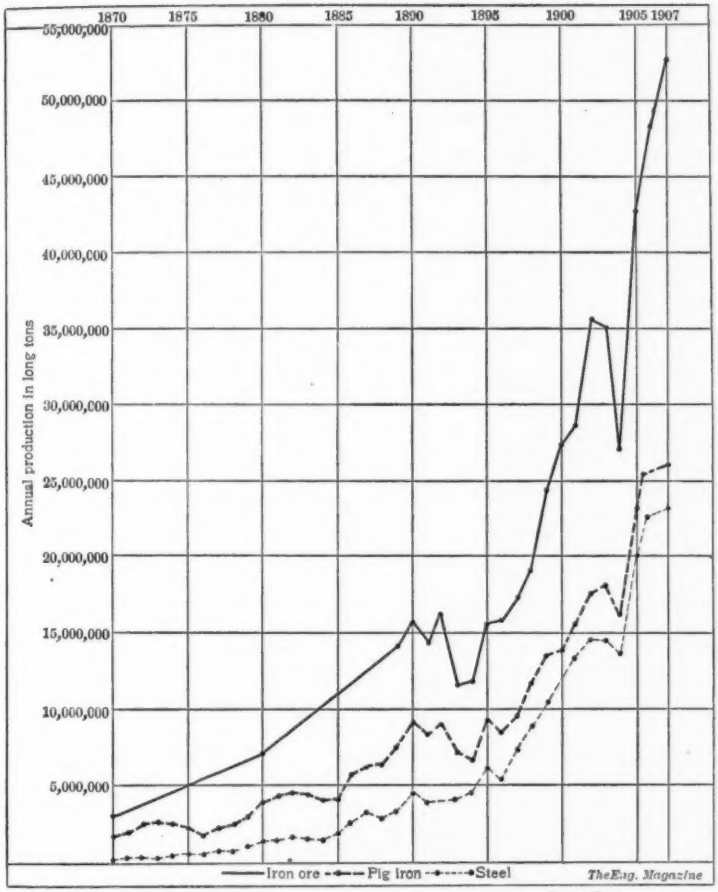
The tonnage of pig iron produced in the first nine months or so of 1907 had been so great that even the shut-downs of the latter part of the year were not sufficient to carry the year's total below the 1906 record. In consequence, the final figures for the year, just published by Mr. James M. Swank, of the American Iron and Steel Association, show that in 1907 the furnaces of the United States produced 25,781,361 tons of pig iron, as compared with 25,307,191 tons in 1906. A more detailed statement of this production by States, as compared with the output of the two preceding years, is presented in the following table:

TOTAL PRODUCTION OF PIG IRON, 1905-1907, BY STATES.

	Production, including spiegeleisen and ferromanganese, in long tons.		
	1905.	1906.	1907.
Pennsylvania	10,579,127	11,247,869	11,348,549
Ohio	4,586,110	5,327,133	5,250,687
Illinois	2,034,483	2,156,866	2,457,768
Alabama	1,604,062	1,674,848	1,686,674
New York	1,198,068	1,552,659	1,659,752
Virginia	510,210	483,525	478,771
Tennessee	372,692	426,874	393,106
Colorado, Missouri	407,774	413,040	*b* 468,486
Maryland	332,096	386,709	411,833
New Jersey	311,039	379,390	373,189
Wisconsin, Minnesota	351,415	373,323	322,083
Michigan	288,704	369,456	*a* 436,507
West Virginia	298,179	304,534	291,066
Kentucky	63,735	98,127	127,946
Georgia, Texas	38,699	92,599	55,825
Connecticut, Massachusetts	15,987	20,239	19,119
Total	22,992,380	25,307,191	25,781,361

b. Including also small output in Pacific Coast States.
a. Including Indiana.

The relation of the year 1907 to the recent past of the American iron and steel trade is, however, brought out more clearly in the following diagram, than could be done in tables. The curves here shown—page 885—represent the production of iron ore, pig iron and steel respectively in the years 1870 to 1907 inclusive. All the data used in preparing the diagram are official except the production of iron ores and steel in 1907, which are believed to be close estimates. On examining this figure it will be seen that 1905 and 1906 showed



PRODUCTION OF IRON ORE, PIG IRON, AND STEEL, 1870-1897.

a most remarkable growth in the output of all three products. In 1907 this growth was sharply checked in the case of pig iron and steel, but the iron-ore production could not be slowed down in time. The result is that the stocks of iron ore now on hand are probably larger than ever before at the same season of the year.

So far as can be foretold now, the production figures of 1907 will remain as record figures until 1909 and possibly longer. It is very unlikely that the recovery from the present depression will come soon enough to give 1908 a chance to surpass or even approach the figures of 1907. The prospects are briefly discussed later.

Price-Cutting versus Shut-Downs.

An examination of the respective courses followed by the copper and iron industries during the past year discloses interesting differences of policy. At the beginning of every period of severe commercial depression, owners of mines and manufacturing plants are usually offered two alternative ways of adjusting their business to the changed conditions. They may keep on with practically no reduction of output, trusting to reduction of price to bring about a strong consumptive demand. This course of action may finally lead to selling their product below cost, for a greater or less time. On the other hand, the situation may be met by reducing the output, and waiting until demand reasserts itself naturally. This may lead to an absolute shut-down of the works if the period of depression is prolonged.

In some manufacturing businesses, particularly in those making a special or distinctive line of goods, there is a possibility of reasonable choice between these two alternatives. In this case the manufacturer may argue that the fixed charges of his investment are great, relative to his operating costs; that his trade may be secured by rivals in case of a shut-down; and that his office and mill force, especially if it includes many highly trained men, will be hopelessly scattered and disorganized.

With a mine, or a mill manufacturing any of the great staples, these arguments have less weight. A mine which sells its product at less than cost, or even at an unfairly low profit, is simply using up its supply of raw material without being properly recompensed for it. It is drawing on a fixed and limited reserve of ore which is becoming naturally scarcer and more valuable each year. It is doing this, moreover, in order to supply a demand which if not satisfied at the moment would simply accumulate until it became strong enough to justify fair prices. Its product is in no way different from that of other producers of the same metal, so that it has no individual "trade" to lose by a shut-down. Its working force is relatively simple and easily reorganized after a stoppage. The same statements which apply to a mine are true, though to a somewhat less extent, of industries whose product is made directly from mineral raw materials, and whose output is substantially the same in grade throughout the country. Iron furnaces and cement plants are manufactories of this type. In industries of this class it is better to try to maintain reasonable prices by curtailment of output or by total shut-down, than to try to encourage sales by serious price reductions.

There is, it is true, a third possible mode of action, but it demands such enormous working capital and such an unfailing trust in the

future that it is rarely possible to carry it out in any large industry, except to bridge over a brief and temporary period of depression. It is to run the mine or mill as usual, and stock the product, not forcing it on the market.

In reviewing the industrial history of the year it has been seen that the leading American copper producers tried all three of these plans in turn, and tried them in an order which inevitably led to disaster. The principal iron interests are trying the second method named—reduction of output. The October panic had scarcely ended when, warned by decreases in new buying and by attempts to cancel orders already booked, the leading iron and steel producers took active steps to prevent entire demoralization in the industry. Acting on the initiative of the United States Steel Corporation, meetings were arranged at which leading interests decided upon substantial unity of action in these matters. It was argued that as producers had not forced consumers to pay unreasonably high prices for steel products during the boom, there was now no reason to market products at unprofitably low prices during the depression. It is probable enough that if the present depression is unexpectedly prolonged, prices will be gradually lowered to some extent, but it is very unlikely that we shall witness the extreme demoralization in prices which has accompanied other periods of poor business. And the lesson of the panic will not have been entirely wasted if buyers are taught that a contract is not a one-sided affair, to be enforced or cancelled at the buyer's option.

The Strength of the Independents.

The fact that concerted action is possible is due largely to a factor often overlooked by those who are interested only in the stock-selling side of the steel industry. That factor is the existence at present of a number of strong and well-equipped independent companies. In the extreme west the Colorado Fuel & Iron Co. is in a strong technical position, through its control of coal and iron lands, though its financial results have been far from brilliant. Jones & Laughlin and the Republic Iron and Steel Company are strongly established in the Pittsburg-Ohio district, while the latter company has also important Southern holdings. The Lackawanna Steel Company at Buffalo lost the principal benefits of the past period of prosperity, but should hereafter be a noteworthy competitor. In central Pennsylvania and eastward are the Pennsylvania, Cambria, Midvale, and Bethlehem steel companies, and several strong furnace interests—Wharton, Thomas, Empire, etc. In the South, now that the Tennessee company is a subsidiary of the Steel Corporation, the leading

independents are Sloss-Sheffield, Republic, and Woodward, none of which has as yet taken up steel manufacture.

Some of the independent iron and steel producers, of course, exist simply on sufferance, and will find it hard to keep alive through any prolonged period of depression. The majority of those noted above, however, seem to be at least as strongly based as the Steel Corporation itself.

A number of the independent producers are particularly strong in their possession of large supplies of raw materials, and in their relatively low fixed charges. These factors are important even during a period of prosperity, but they become vital during business reactions. Small bond-issues, cheap coke, and cheap ore will enable even a small plant to meet the competition of a much larger concern heavily loaded with fixed charges or deficient in supplies of raw material. Some very remarkable differences are revealed when the capitalization of different companies is compared, using as a basis their relative output of pig iron or of steel per year.

The Steel Corporation in the South.

In the latter part of 1906 the event which gave promise of having the greatest influence on the future of the American iron industry was the acquisition of the so-called Hill or Great Northern ore lands by the United States Steel Corporation. This lease removed from the market the only large remaining tract of undeveloped Lake Superior ore lands, strengthened the Steel Corporation's ore reserves immensely, and made it obvious that future competition could not effectively be based on the Lake district ores.

During the latter part of 1907 another step, of still greater importance, was taken by the Steel Corporation, in entering the Southern field. This advance was an indirect and rather unexpected result of the October break in the stock market. A few years ago interests closely allied to those already in control of the Republic Iron & Steel Co. secured control of the Tennessee Coal, Iron & Railroad Co. Extensive improvements were inaugurated, and it seemed as if the Republic-Tennessee combination would soon be a serious rival to the larger Steel Corporation. The financial crisis of 1907, however, delayed the renovation of the Tennessee properties, and at the time of the October panic it developed that the stock necessary for the control of the Tennessee company was being carried by a New York bank which was itself in urgent need of assistance, and which could not readily realize on this stock in the state of the market. The difficulty was solved by the acquisition of the Tennessee company by the Steel Corporation, Steel Corporation bonds being ex-

changed for Tennessee stock. As the bonds were saleable enough the banking difficulty was relieved, and the Steel Corporation absorbed a company which might have proven troublesome in the future.

This acquisition is a matter of importance, both to the Steel Corporation and to the Southern iron industry. To the Steel Corporation it means that very large reserves of coal and iron ore have been secured on a ridiculously low valuation, and that with one step it becomes the leading iron and steel producer of the South. Of greatest immediate value is the fact that it secures an open-hearth steel plant and a rail mill full of orders. To the Southern iron industry in general the advent of the Steel Corporation promises to bring greater steadiness and a more rapid advance in development, particularly along the line of finished products.

Seaboard Plants and Foreign Ores.

One feature of American industry to which relatively little attention has been paid is the necessity for providing for the handling of water-borne trade—coastal and export—in an efficient and economical manner. This lack of foresight is particularly noticeable in the iron trade, now that we have reached the stage when exports are of interest. I recently had occasion to examine and report upon this situation in connection with a closely related industry, and the general conclusions then reached may be summarized as follows:

The best steam and coking coals in the United States are those of the Appalachian coal field, which reaches from Pennsylvania to Alabama in a belt trending almost parallel to the Atlantic Coast, and distant 150 to 350 miles from it. These Appalachian coals are, in general, far superior to those of other portions of the United States. For most of its extent this coal field is paralleled, on its eastern or coastal side, by a series of extensive iron-ore deposits. These iron ores, however, though enormous in quantity, are usually of relatively low grade; but they can be placed on the seaboard at a very low price per unit of iron. A plant located at the coastal end of a coal-carrying railroad could therefore depend on securing a cheap supply of high-grade fuel, and a cheap suply of low-grade domestic ore. But it would also be in a position to avail itself of still cheaper supplies of high-grade foreign ores, imported from Canada, the West Indies, South America and Spain. The duty on such ores is rebated in case the products made from them are exported, but even without this provision the ores used by a seaboard plant would not cost more than Lake ores at Pittsburg.

In view of these facts it is remarkable that only one plant—that of the Maryland Steel Co. near Baltimore—is located so as to take

advantage of this situation, though several eastern Pennsylvania plants depend partly at least on foreign ores. The principal points which offer the combination of factors necessary for the success of a seaboard steel plant are Baltimore, Norfolk, Brunswick, Pensacola and Mobile. Of these, Norfolk has such distinct advantages that it is improbable that it will long remain entirely undeveloped.

The Prospects for the Future.

At the date of writing it cannot be said that any improvement in industrial conditions has set in since October, or even that there is any immediate prospect of such improvement. Money conditions have eased, as is usual after such a crisis, but railroad earnings are showing decreases and general trade is stagnant. In the American iron industry, for example, furnaces with a total maximum capacity of about 30,000,000 tons of pig iron per year are now being operated at a rate of not much over 12,000,000 tons. Few expect much improvement until the early summer, the majority probably believe that improvement will be delayed until after election, while an extreme minority hold that we are on the verge of a long drawn out industrial agony such as that of 1893-1896.

As an offset to purely temporary financial embarrassment and to political agitation which, though less temporary, will not always be with us, there are many factors which are even now at work to bring about better conditions in the iron trade. Basal conditions are sound, thanks to conservative action during our time of prosperity. There is hardly an iron producer, large or small, which is not in infinitely better technical and financial condition now than in 1903. During the past four years most companies have spent more money on improvements, or on decreasing fixed charges, than they have disbursed in dividends. The saving feature of the situation is the rapidity with which production was curtailed, when once the change in conditions had become obvious. Our reserves of iron ore and of good coking coals, though still large, are being decreased every year. These raw materials in consequence, are gradually increasing in value, and there is little justification for drawing heavily on them during a period of depression. The natural increase in value of raw materials, taken in combination with the sound financial condition of most producers, is a guarantee against demoralization in the industry. Stability in prices is causing what may be called an accumulated demand for iron and steel products, and when once consumers feel free to commence buying, it is probable that the resumption in activity will be rapid. This is particularly true of the railroad trade, for large quantities of rails and material are urgently needed by American railroads.

THE PRODUCTION SYSTEM OF THE WESTINGHOUSE ELECTRIC AND MFG. COMPANY.

By H. M. Wharton.

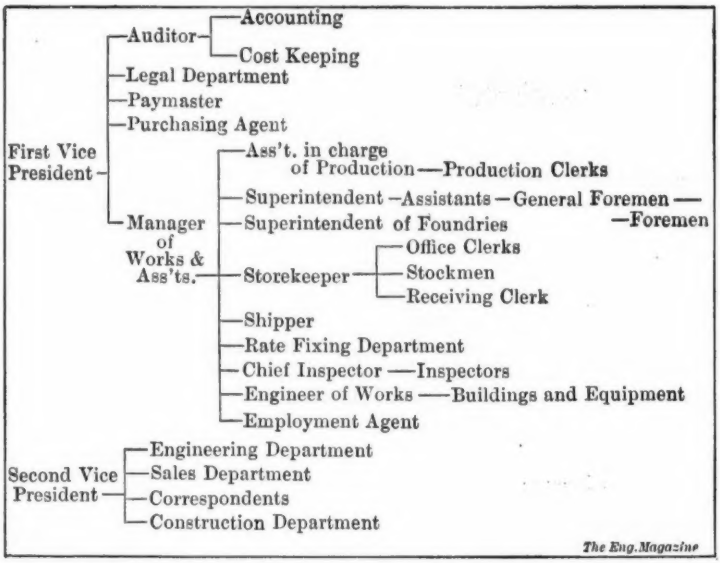
Mr. Wharton was engaged in various capacities in the Westinghouse Electric & Manufacturing Company's works for twelve years; for four years he was assistant superintendent in charge of production, and for three years engineer of works. He therefore writes from intimate pesonal knowledge of the production system of this establishment—one of the most interesting and effective in the world—and his faculty for exact and descriptive expression makes the organization and its practical workings appear before the reader in complete outline and in correct perspective.—THE EDITORS.

THE ultimate purpose of any manufacturing organization being to produce certain finished articles that are to be sold, it may be said that, from the purchaser's point of view, the whole organization is engaged in production and, therefore, that a description of its production system would mean a description of the methods used throughout the entire organization.

For the purpose of this article, however, a more restricted definition has been assumed for the word "production," and only those methods are considered which are used by the departments directly concerned in creating the product. Even with this limitation, an accurate description of the method of regulating production in a large and complex organization would be possible only by exhibiting the multiplicity of forms used, necessitating an article of great length and of questionable interest. It has been deemed best, therefore, to outline only the general method of procedure, omitting, as far as possible, all confusing details.

Under the plan of organization of the Westinghouse Electric and Manufacturing Company there are six departments directly concerned in production, viz:—1. The Correspondence Department, 2. The Engineering Department, 3. The Purchasing Department, 4. The Manufacturing Department, 5. The Raw and Finished Material Stores, 6. The Shipping Department. The heads of the first three report directly to one of the vice-presidents while the last three are in charge of the manager of works who reports also to a vice-president.

Although the selling force cannot be properly classified with those departments engaged directly in production, yet, in order to give a proper understanding of the general system, mention must be



GENERAL OUTLINE OF ORGANIZATION, THE WESTINGHOUSE ELECTRIC & MFG. CO.

made of the fact that district sales offices are maintained in most of the larger cities and that practically all negotiations with either real or prospective customers are conducted by the managers of these offices as agents for the company. The district office, therefore, is an important element in the line of communication between the customer and the works, since all correspondence with the customer is transmitted through the nearest district office.

THE CORRESPONDENCE DEPARTMENT.

This department handles all correspondence between the works and the district sales offices relative to preliminary inquiries and shipping orders, the district offices holding no communication upon these subjects with any of the other works departments. Although for convenience it is so arranged that each correspondent devotes his attention to some particular class of apparatus, it is not to be supposed that he can answer unaided the variety of questions constantly being asked, many of which are highly technical. It is usually necessary to obtain from some of the other works departments the information needed to answer an inquiry, but the official answer is dictated by the correspondent and the letters are filed in his office.

In case a preliminary inquiry from a customer finally leads to an actual order, this order is also transmitted by the district agent to

the correspondent and the latter, having at hand all the papers referring to the subject, is then in a position to enter the official order covering the apparatus that is to be shipped to the customer. Such an official order is called a "general" order and, as usually made out, bears a serial number and contains a complete list of all the apparatus wanted, together with the directions for shipping and billing to the customer. No attempt is made to segregate different types and sizes of apparatus for convenience in manufacture by issuing separate general orders for each, because, as will be explained further on, the general order is not a manufacturing order.

After a general order has been entered the correspondent must still keep closely in touch with it during its progress through the works, to inform the customer of the probable date of shipment.

RAW AND FINISHED-MATERIAL STORES.

Theoretically, all shipments are supposed to be made directly from the stock of finished product carried in the warehouse, manufacturing orders being issued from time to time to replenish that stock or to maintain it at certain prescribed limits; and as the storekeeper is the custodian of all finished product, as well as of the raw-material stores, all shipping orders, or *general orders*, are issued to him and not to the manufacturing department. Whatever manufacturing orders are necessary for apparatus to be supplied to maintain the warehouse stock are issued by the storekeeper and are known as "stock orders."

In the actual carrying on of a business which includes the building of a great deal of large and costly special machinery, it would not be possible, of course, to keep such special machinery in stock. Orders of this kind, however, are handled in the same way as orders for standard apparatus regularly kept in stock—a *general order* is issued to the storekeeper, who in turn issues *stock orders* for the apparatus to be manufactured—the only difference being that a notation is made upon the stock order of the number of the general order for which the particular apparatus is wanted.

Although a general order, as previously explained, may call for a variety of types and sizes of apparatus, a stock order, on the other hand, is limited to only one type and size although it may call for any convenient number of completed units. In other words, as a stock order is purely a manufacturing order, every complete unit made for any given stock order must be identical with every other unit made for the same order. Copies of all stock orders as they are issued are sent to the engineering department, to the manufacturing department, and to the cost-keeping department.

STOCK SPECIFICATION MINIMUM AVR.			Mfg. Min. orders must not be placed for less than this amount	Carry in Stock and on order ___ month's supply based on issues	AVERAGE MONTHLY ISSUES						Description	Style No.
NO.	AMT.	TOTAL			DATE	AMT.	DATE	AMT.	DATE	AMT.		Assembling Section

ORDERED				REQUIRED BY SPECIFICATION		BALANCE AVAILABLE	RECEIPTS					ISSUES							
DATE	REQUISITION NO.	QUANTITY	ORDER NO.	QUANTITY	QUANTITY	DATE	INVOICE NO.	REQUISITION NO.	QUANTITY	TOTAL RECD.	PRICE	COST	DATE	STOCK ORDER SHIPPING REPORT NO.	QUANTITY	TOTAL	COST	IN STOCK

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HEADINGS AND RULINGS OF STOCK LEDGER. ORIGINAL PAGE IS 14 BY 17 INCHES, ADAPTED FOR LOOSE-LEAF BINDING.

Upon receipt of a general order in the storekeeper's office provision for the shipment must be made at once by ascertaining from the stock ledgers which of the items called for are in stock and which items must be provided for by means of stock orders, these orders being issued immediately. A record is then made upon the original order sheet, and also upon the carbon copies attached, opposite each item, stating either that it is in stock or else giving the number of the stock order upon which it is to be manufactured. The original general order sheet is retained by the storekeeper for his use and that of the shipper, while the carbon copies are returned to the correspondent who is thereby informed as to the numbers of the stock orders which have been entered to provide for the apparatus wanted for that general order. These numbers are necessary in dealing with the manufacturing department as that department keeps no file of general orders. Orders for repairing apparatus that has been shipped back for that purpose and is to be returned to the customer after being repaired are not considered to be orders for stock, and are, therefore, handled according to a somewhat different method. Such orders are issued by the correspondent directly to the manufacturing department, a copy going to the storekeeper and to the shipper.

The whole stores system being built upon the theory that a stock of both finished product and raw material will always be maintained sufficient to meet the expected demands, it may be of interest to note the system of accounting used to accomplish this result without an excessive investment in material.

As will be shown further on, the engineering department determines what material shall be used for manufacturing purposes and issues to the manufacturing department bills or lists of the material required for every stock order. Copies of these bills are sent to the storekeeper at the same time so that he may know in advance what he will be required to provide.

The material accounts are all kept in the storekeeper's office, but in order to reduce the expense of handling to a minimum, the raw-material storerooms are so distributed throughout the works that each class of material may be kept as near as possible to the section of the works in which it will be used. Each of these storerooms is in charge of a stockman, and material is issued from them only upon requisitions signed by the shop foremen. As the stockman is responsible only for the stock itself and not for the accounts, all requisitions he receives are forwarded to the storekeeper's office where they are used to make the proper entries in the stock ledgers.

The sample page of one of the stock ledgers shown somewhat reduced in size will give a very fair idea of the storeroom accounting system and will serve to show that the intention is to make its operation as nearly automatic as possible and not dependent upon the judgment of the men in charge of the ledgers. The form shown is used for both classes of accounts—finished-stock and raw-material. The first of the upper row of columns is used for raw-material accounts to show the minimum amount of material liable to be drawn for any one order. The next column is used for finished-stock accounts to show the minimum number of pieces that can be manufactured economically. The supply to be carried in stock is determined from time to time by the storekeeper after consultation with the heads of other departments interested. The lower columns headed "Cost" are for inventory purposes. The amount "In Stock" is of course the difference between "Receipts" and "Issues." In the column headed "Required by Specification" are posted the amounts required for each order as shown by the bills of material from the engineering department. As these bills are received the amounts required are entered in this column and the total subtracted from the sum of the amounts given under "Ordered" and "In Stock," leaving the "Bal-

ance Available" which is the key to the successful operation of the system. Expressed in the form of an equation:

"Balance Available" = "Ordered" + "In Stock" — "Required by Specification."

Abstracts from the stock ledgers showing the condition of the stock of certain classes of apparatus are issued weekly for the information of the selling force and the manufacturing department.

Requisitions for new material are sent to the purchasing agent as the accounts show such purchases to be necessary. These are approved by the storekeeper and duly entered in the ledgers, a copy being sent to the receiving clerk stating to which storeroom the material is to be delivered when it arrives. Receipts of material are entered in the ledgers from the reports furnished by the receiving clerk who is required to make out a report of everything received in the works.

The Engineering Department.

The engineering department is responsible for all matters of design, both electrical and mechanical, and furnishes the specifications, drawings, bills of material, and all other engineering information necessary to enable the manufacturing department to make the apparatus called for by stock orders.

For every stock order a list is furnished by the engineering department of all the drawings that will be needed for that order, together with the information as to which sections of the shop are to make the different parts—or in other words, the "routing" of the order through the shop. This routing is established, of course, only after consultation with the mechanical experts of the manufacturing department.

All drawings according to which parts are to be manufactured are accompanied by bills of material giving every item of material required to make such parts. These bills are sent not only to the shop but to the storekeeper and to the cost department as well. The storekeeper's copies serve as advance information of the drafts that are to be made upon his stock, and enable him to place his requisitions for material as far as possible ahead of the actual requirements. In the cost department they are used in determining the material cost of the apparatus manufactured.

When new drawings do not have to be made the engineering information can easily be issued without serious delay and the programme for the work in the shop can be laid out in accordance with the time of delivery specified on the order. In case new drawings are required, however, a schedule, giving the dates set for com-

pletion of the drawings for each part, is made up as soon as possible and sent to the shop so that the shop schedule can be prepared without waiting for the receipt of the drawings. A copy of this schedule is kept in the drawing office until the drawings are finished.

For apparatus that has been made standard and given a style number permanent drawing lists are retained in the shop. Orders for apparatus of this kind, therefore, require no attention on the part of the engineering department.

THE MANUFACTURING DEPARTMENT.

The shop is under the direct charge of the manager of works, who with his assistants is responsible for the equipment and maintenance of buildings, tools, and machinery, for the manufacturing methods pursued and methods of paying the operatives, for the discipline maintained, and for the quantity, quality and cost of the output.

Under the plan of shop organization adopted the works are divided into a number of smaller shops, known as "sections," each equipped for the manufacture of a particular class of apparatus. To avoid duplication of equipment, certain operations, such as coil winding and insulating, punching sheet steel, pattern making, and foundry work, which are common to a number of different classes of apparatus, are performed in separate sections devoted exclusively to such work.

Each shop section is in charge of a general foreman and a production clerk, and for convenience is subdivided according to the nature of the different operations to be performed, each group of operations being directed by a foreman who may have one or more assistants.

Copies of every stock order as it is issued by the storekeeper are sent to each shop section that will have any work to do in connection with that order, and for the information of the production clerks the order sheet gives the required date of delivery and states whether the apparatus is for stock, or gives the number of the general order for which it is wanted and the name of the correspondent who entered the general order. The delivery date, of course, is of most importance to the production clerk of the section in which the apparatus is completed or assembled, and as it is usually necessary to establish the dates for completion of parts according to the requirements of the assembling section, the production clerk of that section assumes the burden of setting all dates for parts furnished by other sections, as well as for the finished apparatus.

When a stock order calls for apparatus the design of which has been standardized and given a style number, the clerk, after re-

ceiving the order, does not have to wait for further instructions but has only to turn to the permanent information issued by the engineering department for that style number to get the list of drawings and the bills of material necessary. He then makes out a card for each foreman in his section, giving him the number of the stock order, a brief statement of what it calls for, the name of the part upon which work is to be done, the numbers of the drawings upon which the part is detailed, the date set for the delivery of parts made by other sections, and the date upon which the foreman must have his work finished. At the same time he sends notices to the production clerks of the other sections of the shop from which parts are to be supplied, advising them when such parts must be delivered to the assembling section. The clerks of these sections thereupon issue similar cards to the foremen in their sections.

Upon receiving a date card from the production clerk the foreman first ascertains whether he has blue prints of the drawings specified. If not, they are ordered from the blue-printing room. He then estimates the length of time required to do the work, and from the date of completion given on his card he sets a date for starting his work and files his card under that date. In case it is impossible, on account of other work, to finish his work by the time specified on his card, the foreman immediately notifies the production clerk and either a new date is set or else arrangements are made, after consultation with the general foreman, for extending the time set for work of less importance. In case a new date is set on orders for stock, the storekeeper, of course, must be notified; but should the apparatus be wanted for shipment on a general order, a date for completion later than that specified on the order itself cannot be set without notifying the correspondent whose name appears on the order.

When the date arrives for starting work the foreman is reminded of that fact by the card in his file, and he makes sure that the work is actually started before transferring the card in the file to the date the work is to be finished. As the storekeeper receives copies of all bills of material issued by the engineering department, it can safely be assumed that material for standard apparatus will always be kept in stock and that the storekeeper will need no advance information as to the time the material will be used by the shop.

Should any unforeseen circumstances arise during the time the work on any part of an order is in progress that will cause a delay in its completion, the foreman immediately notifies the production clerk of his section, who in turn notifies the production clerk

of the section finishing the order and to which the part is to be delivered. It then becomes the duty of the latter clerk to make whatever re-arrangement of the programme may be necessary, or even possible. If shipment will be delayed the correspondent must be notified. Neglect on the part of any foreman to deliver work to another section of the shop at the time specified cannot escape attention, as each production clerk keeps a record of what his section should receive each day and reports such neglect immediately to the clerk of the section in which it occurs.

The method of keeping track of orders for apparatus for which new drawings have to be made and for which special material has to be bought is, in general, the same as that used in the case of orders for standard apparatus, but as the number of possible complications is increased, greater watchfulness is required on the part of the production clerks. For orders of this kind the production clerk of the assembling section makes out a regular schedule for each element, including the tools and patterns and the principal items of raw material. This schedule being based upon the promise received from the engineering office for completion of the drawings, the production clerk must see to it that the drawings are finished as promised, or, if they are not, he must promptly notify the correspondent, who will take the matter up with the engineering department before a serious delay can occur.

As the drawings with their accompanying bills of material are issued, the storekeeper must be advised as to when the material should be brought in, castings must be ordered and the foundry notified when the patterns will be finished, and all other sections must be instructed to have their parts ready by certain dates. As a record of these transactions is made on the schedule, the production clerk or the general foreman, by glancing over the schedule, can ascertain, at any time, what parts have been finished and what the expectations are for the remaining parts.

Upon completion of the order the apparatus is delivered to the warehouse properly tagged, a receipt taken for it, and as far as the manufacturing department is concerned, the order is closed and a report to that effect is sent to the cost-keeping department.

The Purchasing Department.

As its name indicates, this department makes all purchases of material and supplies, and assumes all responsibility for prices; but, as it is not responsible for the maintenance of a sufficient supply of raw material, purchases of such material are made only upon requisition from the storekeeper.

Purchases of tools, machinery, fuel, office furniture, and other supplies which are not classified as raw material for manufacturing purposes and which are, therefore, not kept in the storekeeper's stock, are purchased upon requisitions issued by the department using such supplies. Requisitions for machine tools, for instance, are issued by the manufacturing department and sent directly to the purchasing agent. In all such cases a copy of the requisition is sent to the receiver to enable him to identify the shipment when it arrives and to deliver it to the proper department.

Purchase orders are sent out by the purchasing agent for material wanted to fill the various requisitions as they are received, and as soon as promises of shipment can be obtained, the storekeeper (or other department issuing the requisition) is notified of the probable date of shipment. When material, such as copper, for instance, is used in large quantity and the market price is subject to wide variations, contracts are usually made at periods of low prices for an amount sufficient to supply the needs of the works for some time in the future. The actual orders, however, are placed only as these needs are indicated by the storekeeper's requisitions.

When material is ordered in accordance with patterns, dies, or models which are to be furnished to the dealer, instructions for the shipment of these must be given to the shipper by the purchasing department. Shipping instructions for the return of rejected material are given in the same way.

The Shipping Department.

This attends to the packing and arranges for the transportation of all shipments that are to leave the works. Such shipments can be made only upon general orders or upon instructions issued by the purchasing agent. All general orders, after the storekeeper has made provision to fill them, are passed to the shipper to enable him to make whatever preparations may be necessary, and as each shipment is made, whether on a general order or on instructions from the purchasing agent, a report is sent to the accounting department.

The methods used by any organization will depend largely upon the plan of the organization itself, and upon the character and volume of the work to be done; and the value of any system adopted can be measured by its success in meeting the demands of a rapidly increasing business. Except for some changes of minor importance, the system herein outlined has been used for about fifteen years by a company engaged in the manufacture of practically every type and size of electrical machinery and apparatus, the value of the yearly output having increased during that time about 1,000 per cent.

POWER EQUIPMENT FOR THE SMALL FACTORY.

By Percival Robert Moses.

In the following pages Mr. Moses presents the problems confronting the designer of factory equipment, and shows the more important factors which should receive consideration in determining the character of the plant so that it may do its work in "the easiest and cheapest way—cheapest meaning all things considered, and not lowest in installation cost" only. The author speaks his own conclusions, based upon large experience as a consulting engineer in this special line of practice.—THE EDITORS.

THIS article is limited to the discussion of the "small-factory equipment," by which is meant a factory depending upon one, two or three units with total capacity between 100 and 300 horse power, and with the work confined either to a single building or to a small group of buildings. The conclusions reached, and the methods advised, will apply equally to large factories; but the requirements in such installations are so diverse and the character of the equipment generally so different as to make the consideration of each type of large plant worthy of separate discussion.

The problem presented in the ordinary small factory is the generation and delivery of from 100 to 300 horse power, and its distribution for the purpose of operating various small tools or machines located at several points. Besides the operation of machinery, there is generally a requirement of low-pressure steam for heating, and steam of other pressures for purposes of drying, boiling, evaporation, etc. Power is also required for lighting, and possibly for electric heating; frequently water must be pumped, and fire protection must be maintained. In special classes of work, refrigeration is required for maintaining stated temperatures and humidities, and ventilation, either forced or exhaust, or both, for removing impurities in the air or waste products of manufacturing processes. Each instance, therefore, requires individual consideration in determining the type of plant required and the character of the apparatus needed to secure the best results for the least money. But all such decisions require basic facts of costs of installation and operation, and it is the intention to give these as far as it is possible to do so in a single paper.

In the choice of equipments we are limited practically to five methods of obtaining power:—first, the steam engine; second, the gas engine; third, the oil engine; fourth, water power; fifth, street service.

TABLE.

COST OF PRODUCING 124,000 K.W. HRS. PER YEAR.

Conditions—Plant Operates 10 Hrs. per Day 310 Days per Year.

Character of Plant.	Amount of Fuel. Without heating.	Amount of Fuel. With heating.	Amount of Labor.	Cost of Fuel. Rate of Fuel.	Cost of Fuel. Without heating.	Cost of Fuel. With heating.	Cost of Labor.	Cost of Water.	Cost of Oil, etc.
Steam Plant Non-condensing Coal Fuel	434			2	868	1102	1200	110	500
	377	551	Eng. Fire One Man	3	1302	1653	1200	110	500
				4	1508	1976	1200	110	500
		494		5	1885	2470	1200	110	500
Steam Plant Non-condensing Oil Fuel	2000	2468		.50	1000	1234	900	110	500
				.75	1500	1851	900	110	500
			Eng.	1.00	2000	2468	900	110	500
				1.20	2400	2962	900	110	500
				1.50	3000	3702	900	110	500
Gas Engine and Producer	124	357		2	248	714	900	1200	200	500
			Eng.	3	372	1071	900	1200	200	500
				4	496	1428	900	1200	200	500
				5	620	1785	900	1200	200	500
Oil Engine	600	1532		.50	300	766	900	900	200	500
				.75	450	1149	900	900	200	500
			Eng.	1.00	600	1532	900	900	200	500
				1.20	720	1838	900	900	200	500
				1.50	900	2298	900	900	200	500

Heating is figured for building 80 by 125 x 70 ft. high. New York City conditions.

Fixed charges at 10 per cent include interest and depreciation charges.

The first problem presented to the engineer is the choice between these ways. This may be said to be the most important and the most difficult part of the engineer's work. If he makes a mistake in advising as to the best method of the five mentioned to be employed, and his report is accepted, he may handicap the plant for the rest of its existence; as, after the investment is once made, it is no longer possible to choose on an equal basis between the various methods, the method chosen having on its side the cost of the investment and the cost of making the change, in which latter is included the inconvenience and delay. These are generally sufficient to prevent the change being made, and consequently the plant is handicapped during the rest of its working existence.

There is only one safe way to decide upon this question of power. The probable requirements of the plant being designed should be plotted carefully, either from data from similar plants or, when this

TABLE.

COST OF PRODUCING 124,000 K.W. HRS. PER YEAR.

Plant 75 to 90 K.W. Average Load for 10 Hrs. 40 K.W.

Cost of Repairs.	Total Mfg. Cost, Inc. Heat.	Value of Heating.	Net Mfg. Cost.	Gross Mfg. Cost per K.W. Hr.	Net Mfg. Cost per K.W. Hr.	Fixed Charge. No Allow. for Heat.	Fixed Charge. Allow. for Heat.	Total Cost per K.W. Hr. No Allow. for Heat.	Total Cost per K.W. Hr. Allow. for Heat.
200	3112	936	2176	2.51	1.75			3.32	2.48
200	3663	1170	2493	2.95	2.01			3.76	2.74
200	3986	1402	2584	3.21	2.08	.81	.73	4.02	2.81
200	4480	1635	2845	3.61	2.29			4.42	3.02
250	2994	936	2058	2.42	1.66			3.23	2.39
250	3611	1169	2442	2.92	1.97			3.73	2.70
250	4228	1402	2826	3.42	2.28	.81	.73	4.23	3.01
250	4722	1588	3134	3.82	2.53			4.63	3.26
250	5462	1862	3600	4.42	2.91			5.23	3.64
300 350	2964	936	2028	2.39	1.63			3.24	2.56
300 350	3321	1170	2151	2.68	1.73			3.53	2.66
300 350	3678	1402	2276	2.96	1.83	.85	.93	3.81	2.76
300 350	4035	1635	2400	3.26	1.93			4.11	2.86
200 350	2716	936	1780	2.19	1.43			3.04	2.36
200 350	3099	1169	1930	2.49	1.55			3.34	2.48
200 350	3482	1402	2080	2.81	1.68	.85	.93	3.66	2.61
200 350	3788	1588	2200	3.05	1.78			3.90	2.71
200 350	4248	1862	2386	3.42	1.93			4.27	2.86

The quantity of coal is expressed in tons and that of oil in barrels, both per annum.

All costs are given in dollars, per unit or per annum.

is impossible, from a careful study of the conditions that will exist in the plant when completed.

In making an estimate of the amount of power required from the prime mover, the mistake is made frequently of assuming the average and maximum loads of motors at far too high an amount, and the lighting load also. The ratio of maximum load to connected capacity —i. e., capacity of motors connected—varies from 80 per cent with high-speed continuous machinery, such as wood-working, to 33 1/3 per cent with machine-shop work. This ratio will also be greatly affected by the extent to which subdivisions of power is carried; e. g., the ratio will be much higher if there is only one motor than if there are half a dozen to the floor. In one building, used for sugar manufacture, in which motors were used for cranes, centrifugals, crystallizers, conveyors, pumps, etc., the ratio of maximum load to connected capacity was 33 1/3 per cent; i. e., with 360 kilowatts of motors,

the maximum power load never exceeded 120 kilowatts. In a factory building containing wood-working machinery driven by one motor to each floor for about half the building, and book-binding machinery, sewing machines for garments, and rolling machines for the remainder, also motor-driven, the ratio of maximum load to connected capacity is 70 per cent. In a third, used entirely for printing, with motors partly on each press and partly used for driving groups of presses, the ratio was 30 per cent.

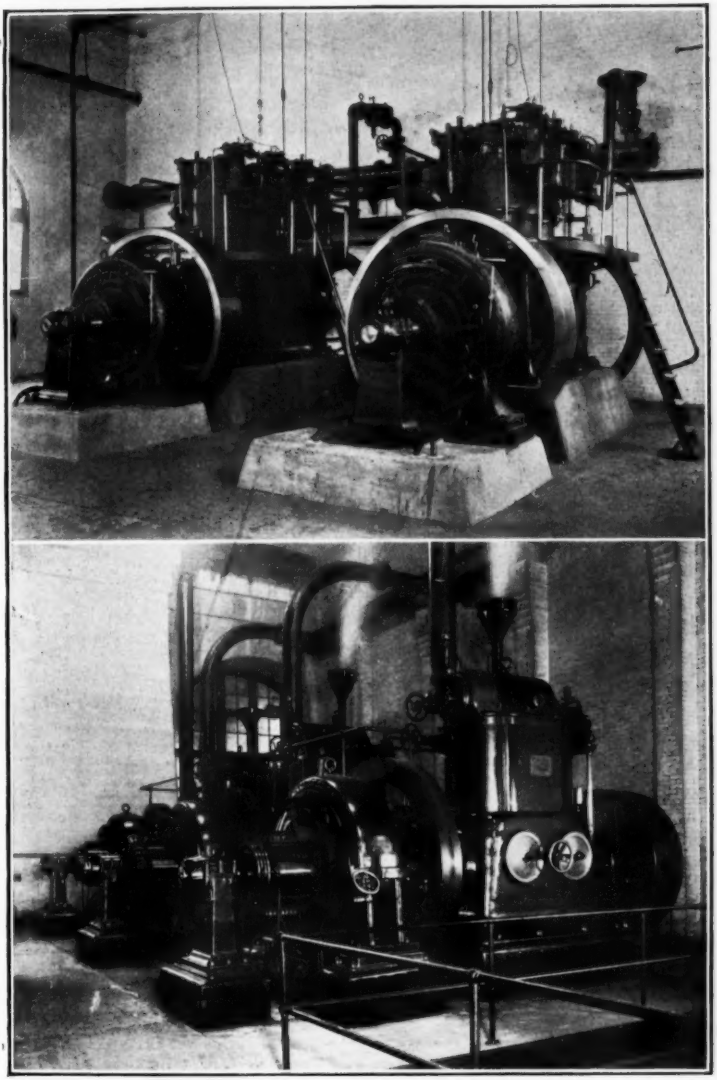
After the probable power and steam requirements have been settled, it is possible to determine which type of power producer is advisable and how much more the purchaser is warranted in paying for one type of producer than for another.

If water power is immediately available in sufficient quantity for the use of the factory, it is almost always the cheapest form of power to use. By this is meant, water power directly convertible into power for operation of machinery—not water power used to drive electrical machinery from a distance perhaps, of fifty or sixty miles. In plants where water wheels can be obtained to develop the power in the mill, the cost is practically limited to the investment charges, the cost of oil and repairs forming a very small fraction of the operating cost. I have figures from a number of water-power plants varying in size from a few hundred horse power up to several thousand, and the repairs on these plants are extremely small. On one 600 horse-power plant, the labor for engineers and switchboard attendant amounted to $1,220 a year, the cost of oil being less than $135 a year, and repairs $500 a year. At another plant, in the southern States, the cost was $1.24 a year per horse power installed; this included the maintenance of the electric equipment, and the total cost of operation in this latter case was less than $5.00 per horse power installed per annum. In plants where logs and ice interfere with maintenance of rack and water way, the cost of repairs, etc., may run up to $3.00 per horse power installed, but this is exceptional.

However, most factories are not located directly on a water power, and the choice is limited to a gas engine, an oil engine, a steam engine, or no engine at all, the service being supplied from a central-station company.

The table of operating costs on pages 902-903 is based upon the following assumed conditions of size and heating requirements:—

The building is 80 by 125, 70 feet high, with weather conditions those of New York and vicinity. In allowing for value of exhaust steam for heating, it is estimated that only one-half the heating re-

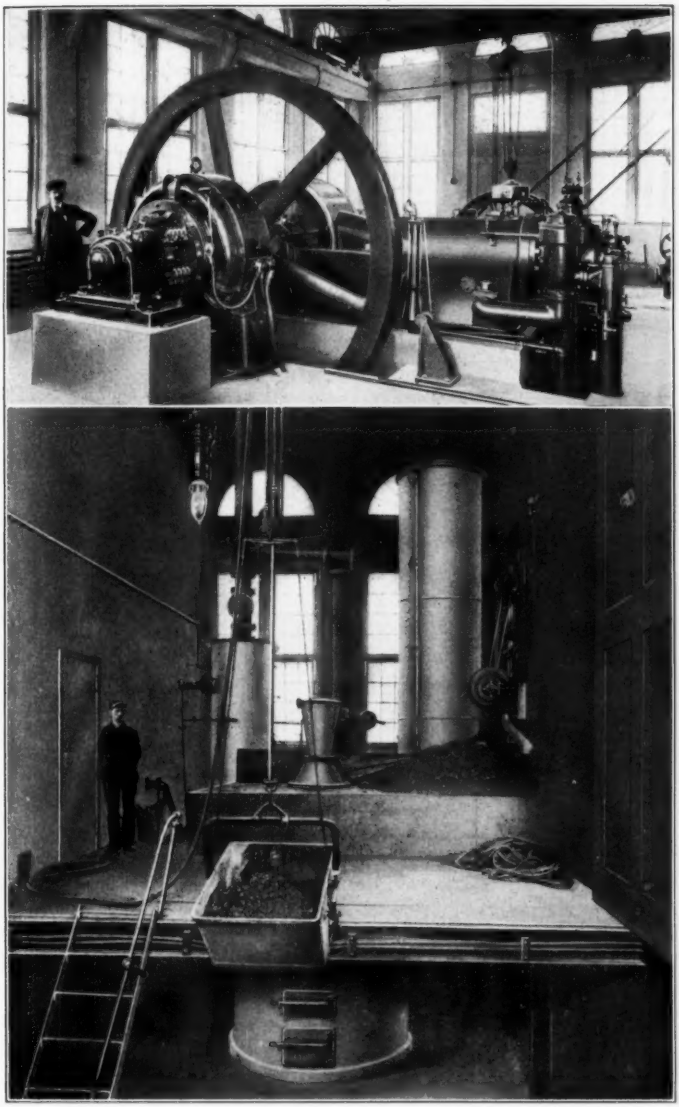


GAS-ENGINE AND HIGH-SPEED STEAM-ENGINE INSTALLATION.

That above is a gas-engine plant installed for the Firth-Stirling Steel Co., Washington, D. C. It consists of two 16 by 18 producer-gas engines, 190 horse power each, supplied by Westinghouse anthracite pressure producers. That below is a high-speed steam-engine installation at the Pittsburg & Lake Erie Terminal, Pittsburg. Three 14 and 24 by 14 compound steam engines of 250 horse power each at 150 lb. Both by the Westinghouse Machine Co.

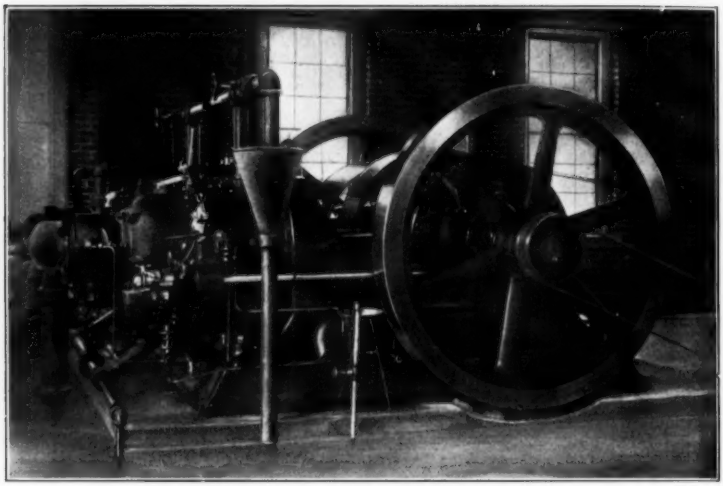
quirements will be supplied by exhaust steam. With oil fuel, four barrels of oil are taken as equivalent to one ton of No. 1 buckwheat coal, and sixty-two kilowatt hours are supposed to be obtained from burning of one barrel of fuel oil under boilers. The latter rate is somewhat low, but probably a fair average for small non-condensing factory plants. The first cost forming the basis of estimate of fixed charges, includes boilers, engines, dynamos, switchboard, steam and wiring connections, steam auxiliary apparatus such as feed heater, separator, pump, stack and foundations. In making allowance for heating, the fixed charges with the steam plant are reduced, because part of the apparatus installed would be required for heating whether a plant were installed or not. With the gas-engine and producer plant, and the oil engine, the first cost is increased (to provide for the heating) by the cost of boiler with setting, stack and connection. The fixed charges do not cover the heating or electric system of the building—merely the provision in the plant to supply these systems. Cost of labor will vary with conditions, but the comparative costs should be about correct. Water is charged at $1.00 per 1,000 cubic feet. Oil, etc., includes waste, packing, gauge glasses, sundries, tools, but no incandescent-lamp renewals or motor repairs.

The table shows the cost of producing 124,000 kilowatt hours a year, with a total connected capacity of between 150 and 200 horse power, and a maximum load of between 75 and 90 kilowatts, the average load between 40 and 50 kilowatts, the operation of the plant 10 hours a day. These are usual factory conditions where the load is a varied one. If the work done is in the nature of wood-working or electric heating, the average will be much higher, but this table will serve to show the relation between the cost with various types of power. It is evident that with the water-power plant omitted, the gas-producer and the gas-engine plant is more economical than steam power where coal costs more than $3.00 a ton, and more economical than oil fuel where coal costs less than $4.00 a ton and oil fuel more than 3 cents per gallon. It seems strange that under these conditions, the gas engine and gas producer have not had a wider application. There are good reasons for this, and the first and most important lies in the requirement of low-pressure steam for various purposes before enumerated. The effect of this is clearly shown in the columns of the table where allowance is made for value of heating and cost of supplying this factor with different types of plant. The second reason is the comparative novelty of the gas engine and gas producer and the consequent lack of standardization and confidence.



KOERTING ENGINE AND SUCTION GAS-PRODUCER PLANT, RUSHMORE DYNAMO WORKS.

Four-cycle 100 horse-power engine direct-connected to 125-volt generator. De La Vergne Machine Co. and C & C Electric Co.



A 65 HORSE-POWER TWO-CYLINDER HORNSBY-AKROYD OIL ENGINE OPERATING ALTERNATING-CURRENT GENERATOR, KUTZTOWN, PA., ELECTRIC LIGHT AND POWER STATION.

One of the few municipally owned plants which is commercially successful; 125 horse-power has been added, of the same type of engine, since the photograph was taken.
The De La Vergne Machine Co.

I think there is little question that the gas engine and gas producer will find a very much wider application than they do at present, and the heat now wasted in exhaust gases and in jacket water will be used in the same manner as exhaust steam in the steam engine. There has been a third reason why the gas engine and gas producer have not been more widely used, though this reason has now practically disappeared; I refer to the excessive cost of the gas engine. A complete gas-engine and gas-producer equipment can now be installed for about the same price as steam boilers, steam engine, smoke stack, and auxiliary apparatus required in a steam plant. Heretofore, or to within the last couple of years, the first cost of the steam equipment was so much less than the cost of the gas-engine equipment that with any low load factor— that is, a low average load as compared to the maximum load—the gas engine was not economically advisable, and this condition still holds true in many instances where the steam requirements are a large factor, in which case the installation of a gas-engine and gas-producer plant does not preclude the necessity of a steam-boiler installation and smoke stack. In some installations where the amount of power used is comparatively small, and the amount of steam very

large, the size of boiler plant may not be in any way increased by the amount of steam used for power purposes, and in such instances the comparison of cost must be made between the cost of the gas engine and gas producer and the cost of the steam engine alone. In such instances the gas-producer plant is rarely advisable.

The following table gives prices per kilowatt capacity of boilers, engines, dynamos, switchboard, steam and auxiliary apparatus required for plant operation, and similar figures for gas engine, gas producer, etc.:—

TABLE OF COST PER KILOWATT CAPACITY.
(Based on personal experience in New York and vicinity.)

	Per Kilowatt Plant Capacity.
BOILERS (erected and set in masonry):	
Horizontal-Tubular	$14—$18
Water-Tube	16— 20
STEAM ENGINES:	
High Speed, Simple Direct-Connected	20— 25
Medium Speed, Compound Non-Condensing, Direct-Connected	28— 35
Low Speed, Compound Condensing, Belted	20— 25
" " Simple Slow-Speed, Belted	25— 30
GAS ENGINES	50— 60
OIL ENGINES	75— 85
GAS PRODUCERS	15— 20
DYNAMOS:	
Direct-Connected to High-Speed Engine	13— 16
Belt-Connected to Engine	12— 15
Direct-Connected to Corliss Engine	16— 20
SWITCHBOARD	5— 10
FOUNDATIONS	5— 10
STEAMFITTING—including auxiliary apparatus—such as feed heater, grease separator, exhaust head, tanks, covering, etc.	20— 30

In the table of comparative costs of operation, costs are shown per kilowatt hour with fuel at $2, $3, $4, and at $5 a ton, and oil at 50 cents, 75 cents, $1.20, and $1.50 a barrel. It is, of course, evident that the cost of fuel and its quality has a very important bearing on the choice of the plant. It may absolutely decide the character of the plant. If wood is plentiful and cheap, wood will be the fuel used, and the plant would be a steam-operated plant. If coal is plentiful and cheap, the plant would still be a steam-operated plant. If coal is expensive, or if wood is scarce, but the only available fuel, the gas-producer plant would be indicated; and if fuel oil is obtainable in large quantities and low price, the choice is restricted to the oil engine and to the oil burner under boilers operating a steam engine.

As between these two propositions—that is, the oil engine and the oil fuel under the boiler—there is little to choose as regards the first cost of the installation. Where steam is required for heating and other purposes, the steam plant has the preference. Where it is not

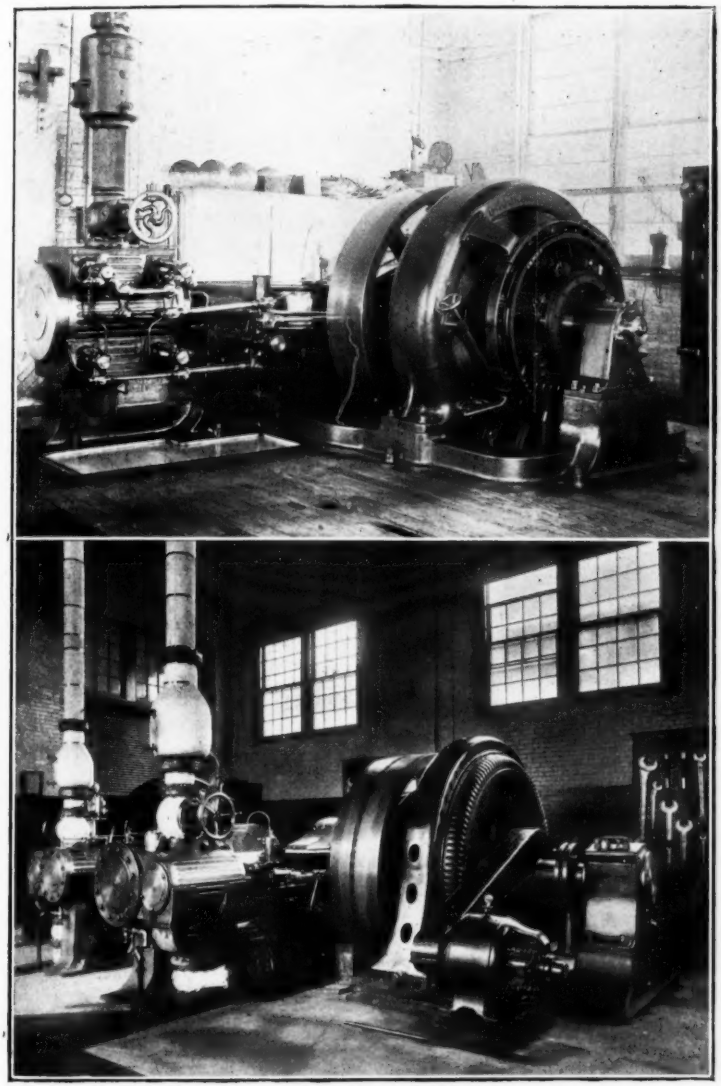
required, there is no objection to the oil engine which, if properly designed and built, is an entirely reliable piece of apparatus, only requiring intelligent care and a little hard work. It has the great advantage of simplicity and small stand-by losses, when compared with a steam-boiler and engine plant.

If there is a supply of natural gas available, the conditions are again different, and the question then becomes one of the cost of natural gas and the requirements of steam for other purposes.

If service from a central plant is available, a direct comparison may be made between the cost per kilowatt hour shown in the table and the price obtainable from the central service. If the size of building and its heating requirements are similar to those noted in the table, the figures may be used directly; otherwise, the value of heating must be computed with the actual requirements in mind. For New York conditions, from 1/3 to 2/3 ton per 1,000 cubic feet per year will be found to be the amount of fuel required for heating, depending upon dimensions of building, amount of heat required, exposure, and construction. To this must be added the cost of operating boilers, including labor, repairs, water, removal of ashes, sundries, and tools. The sum of these items constitutes the value of heating as shown in the table for the typical building.

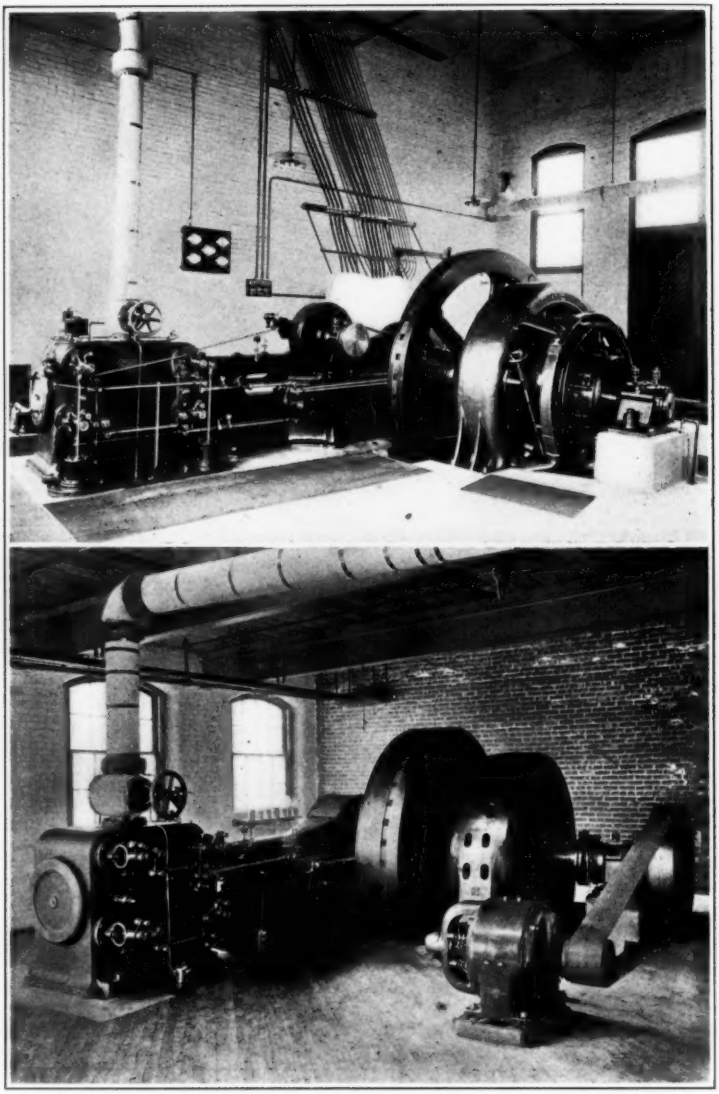
After the question of the character of the power to be used has been settled—that is whether it shall be steam, gas or oil, or water power, or none at all—the question of the type of steam engine or steam boiler to be used, or gas engine or producer, is next to be settled. There are already well defined limits in steam practice for the different types of apparatus. For small powers, that is for 150 horse power or less and steam pressures of 125 pounds or less, the horizontal return-tubular boiler, brick-set, has the preference. Where the capacity of the individual boiler runs up over 150 horse power or over 200 horse power, and where the pressures exceed 125 pounds, it is usual for purposes of safety to divide the heating surface and make the boiler a water-tube boiler.

As between high-speed, medium-speed, and low-speed engines, for rapidly varying loads, and total loads of 150 kilowatts or less, the direct-connected high-speed engine with its automatic oiling system is extensively used. Where space permits, however, the slow or moderate-speed engine is really preferable on account of its heavy weight, the large size of its parts and ample bearing surfaces, and ease of maintenance in its first condition. It is a matter of simple arithmetic to show that if a piston travels over a certain point in the cylinder



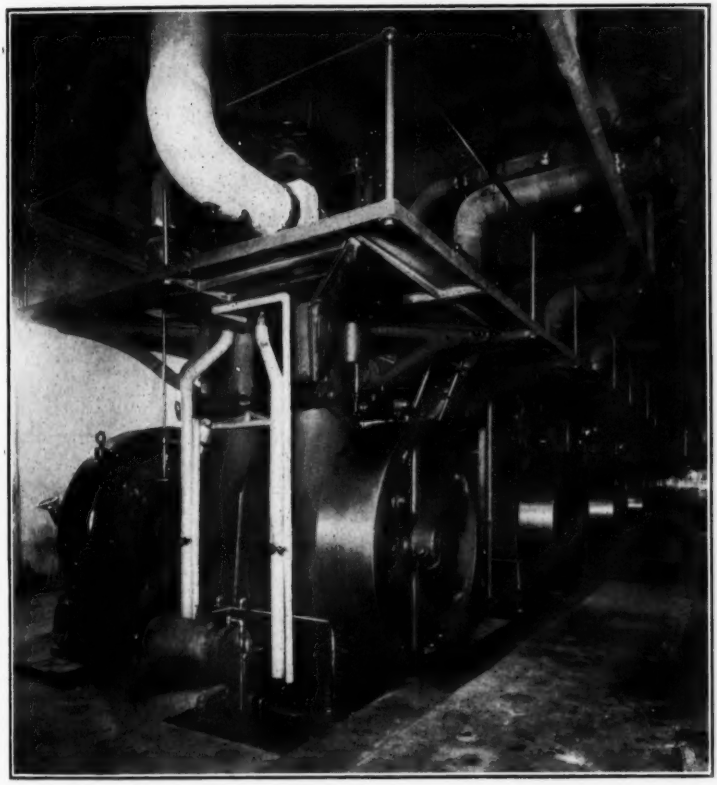
FLEMING ENGINES IN INDUSTRIAL POWER-PLANT INSTALLATIONS.

The upper one is a Fleming medium-speed four-valve engine, 16 by 16, direct-connected to Crocker-Wheeler 100-kilowatt generator, plant of the McClintic-Marshall Construction Co. That below shows the Fleming piston-valve side-crank type, with all reciprocating parts enclosed, driving Bullock alternators. The nearer large unit is 300-kilowatt, with exciter driven by silent chain. The farther unit is 200-kilowatt. The Harrisburg Foundry & Machine Works.



RICE & SARGENT AND FOUR-VALVE NON-RELEASING GEAR CORLISS-ENGINE INSTALLATIONS.

The upper figure shows a releasing-gear Rice & Sargent type Corliss of 150 kilowatts, speed 150 revolutions. The lower is a four-valve non-releasing gear high-speed Corliss engine running a textile mill, size 200 kilowatts, speed 200 revolutions; with belted exciter. Both built by the Providence Engineering Works.



FOUR VERTICAL CENTER-CRANK CROSS-COMPOUND SINGLE-VALVE AUTOMATIC ENGINES, POWER PLANT OF THE FIRST NATIONAL BANK BUILDING, CHICAGO.

Ball engines, each direct-connected to a 150-kilowatt Crocker-Wheeler direct-current generator operating at 225 revolutions. The Ball Engine Co.

300 times a minute, it will wear that cylinder much faster than a piston will traveling over a long-stroke cylinder 100 times a minute, and the same condition, more or less, applies to all parts of the machinery.

In plants where but little steam for heating and other purposes is required, the engines will run condensing; and if the water is poor, the condenser will be of the surface type; if it is good, and the water is plentiful, it will probably be of the jet type. There is only one way to determine whether it will pay to run condensing or non-condensing, and that is to estimate both ways the total cost of running the plant

with a condenser and without a condenser, doing the heating and supplying the other steam requirements.

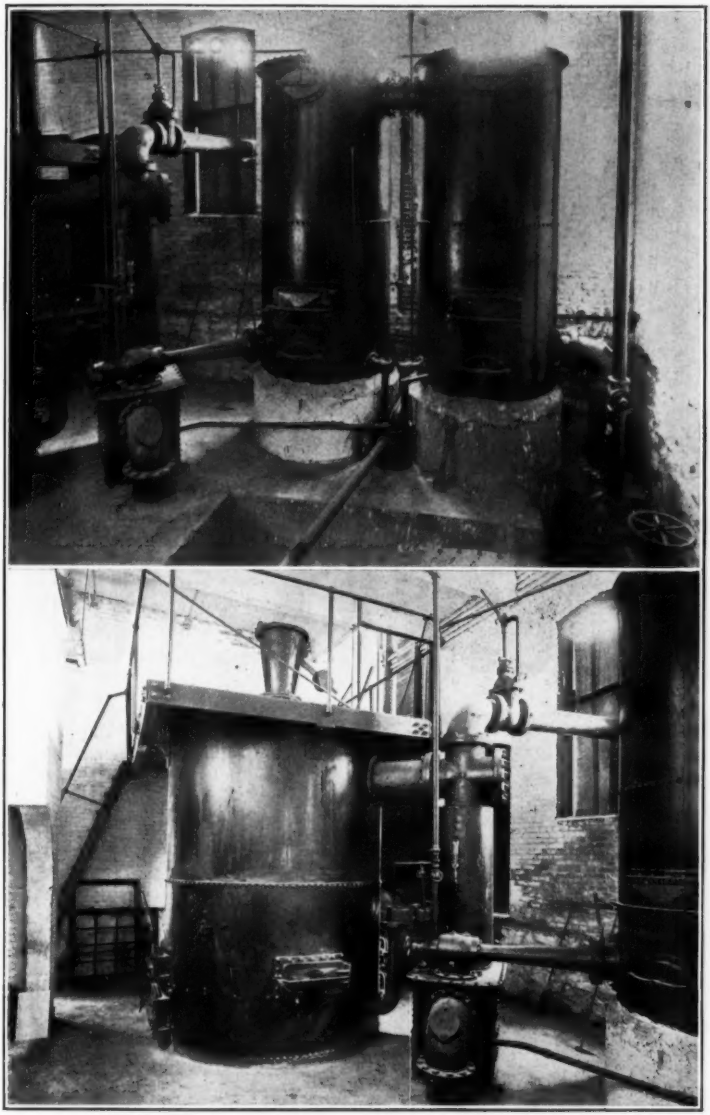
Steam turbines are now making a strong bid for public favor, but they are not sufficiently standard and perfect, in my opinion, to be adopted as yet in small plants. Where they are run non-condensing, their main advantage is in the saving of oil, and this advantage is far more than counterbalanced by the excessive use of steam operating under these conditions. Where they are run condensing, they offer several advantages; viz., the absence of any cylinder oil, tending to foul the boilers, and an economy equal to the best compound-condensing engine, together with small floor space, low cost of foundations, and a very compact installation. The possibility of their use is worth carefully considering where operation condensing is feasible and advisable.

As between vertical and horizontal steam engines, the verdict has been in favor of horizontal engines for 500 horse power or less, on account of the ease of adjustment of the moving parts, and carrying the weight of these moving parts on a solid bed rather than on the moving parts themselves.

As to gas engines and gas producers, the two main varieties are the pressure producer and the suction producer. There are special producers arranged for the recovery of by-products, such as ammonium-chloride, but these are not to be considered in small factory equipments; they become valuable only where the use of coal runs into the hundreds of tons per day. In the usual type of suction producer, anthracite coal must be used, and this system has the merit of simplicity and low first cost. For a single-unit plant, where anthracite is economically available, a suction producer is the best because it is the simplest and least expensive. Where more than one unit is in use, and the units are small in size, the suction-producer plant, if properly piped, is entirely satisfactory; but for large installations, or where bituminous coal must be used, the pressure producer, with gas tanks to receive the gas before it reaches the engine, is preferable.

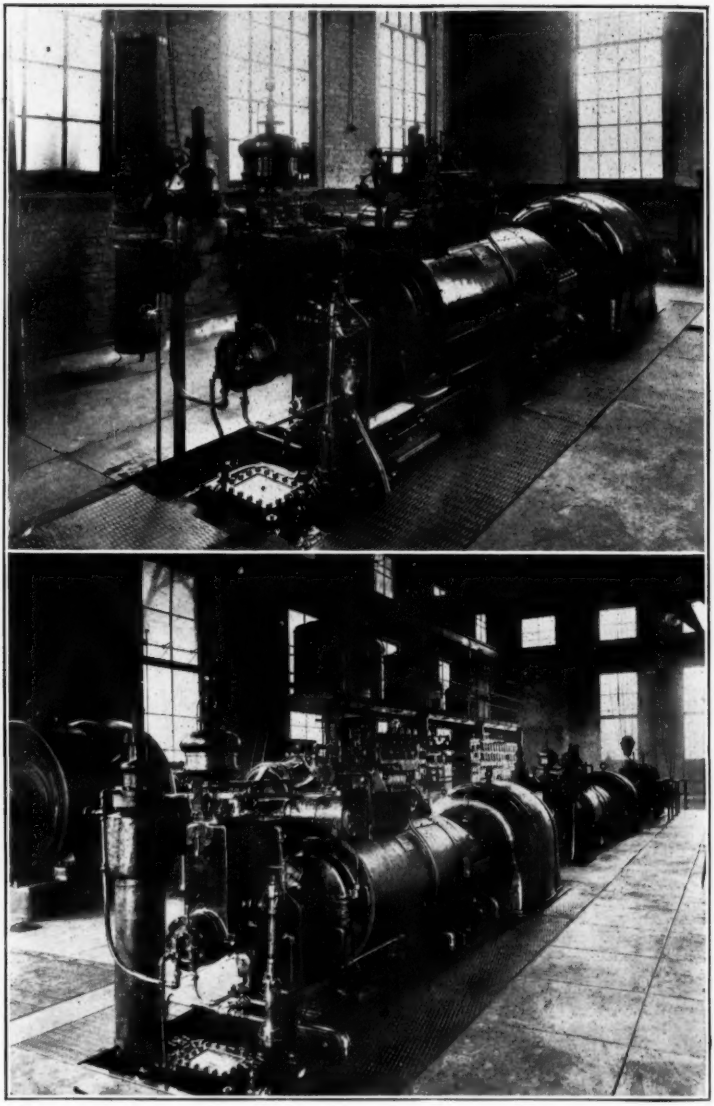
Where bituminous coal is available and anthracite coal is not, on account of its price, the bituminous producer is entirely satisfactory. It requires a great deal more attention than the suction producer and it is harder to maintain, but provided proper arrangements are made for taking out the tar and scrubbing the gas, no especial trouble with the engines need be feared.

Gas engines designed for use with illuminating or natural gas are not suitable for operation on producer gas, unless the power to be



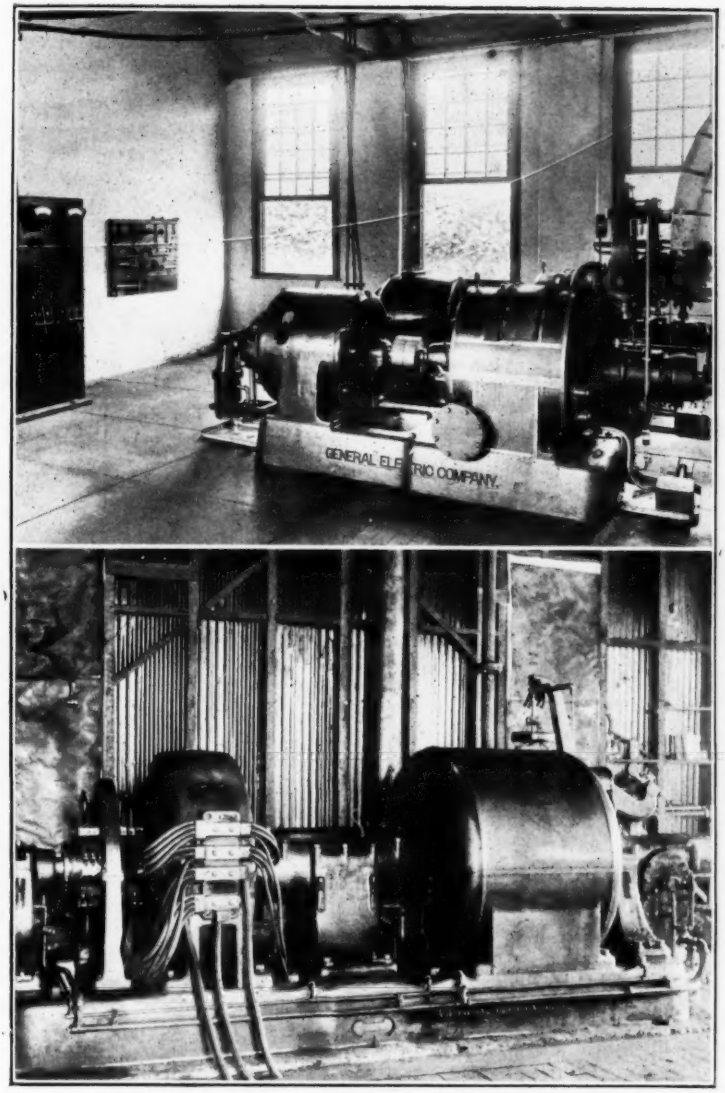
MODERN GAS-PRODUCER PLANT FOR POWER AND FUEL.

A 300 horse-power automatic pressure-producer generator (below) and wet scrubbers (above), installed for the Penn Hardware Co., Reading, Pa., by the Wile Power-Gas Co. Started in February, 1907.



WESTINGHOUSE STEAM-TURBINE INSTALLATIONS IN FACTORY POWER PLANTS.

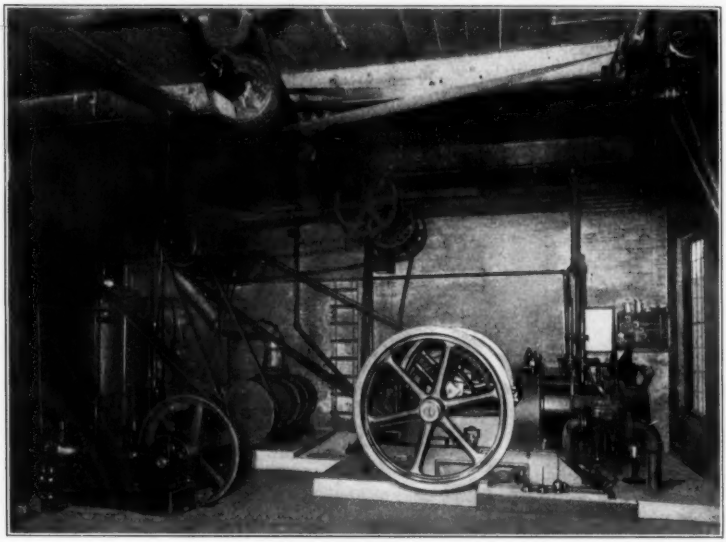
The machine above is in the factory of the Griffin Wheel Co. That below is installed for the Suburban Manufacturing Co., Waltham, Mass. Both by the Westinghouse Machine Co.



CURTIS TURBINE INSTALLATIONS IN INDUSTRIAL PLANTS.

The upper one is a 75-kilowatt 250-volt machine installed for the Ferracute Machine Co. Bridgeton, N. J. The lower is a 150-kilowatt 250-volt turbine at the Wilton, Ky., plant of the North Jellico Coal Co. The General Electric Co.

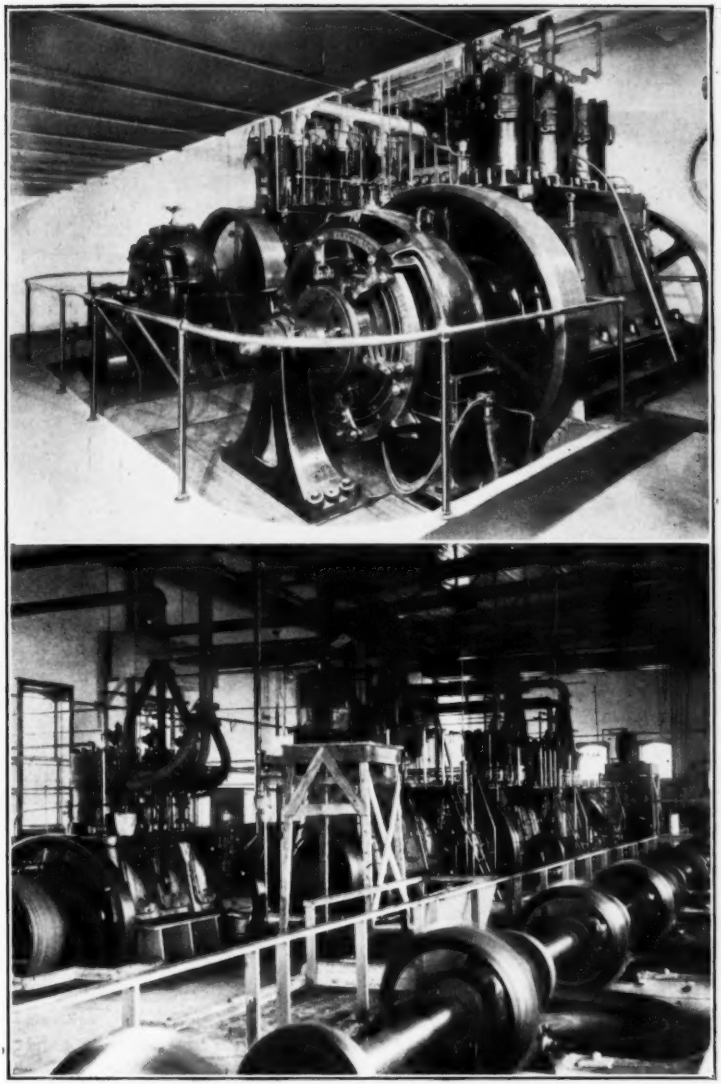
derived from them is very greatly reduced, because producer gas has a value of from 125 to 150 British thermal units only per cubic foot; while natural gas has a value of 1,000 British thermal units, and illuminating gas of 700 British thermal units per cubic foot.



A 50 HORSE-POWER TWO-CYLINDER HORNSBY-AKROYD ENGINE OPERATING GENERAL MACHINERY IN A FOUNDRY.

The De La Vergne Machine Co.

Oil engines of the Diesel or Hornsby-Akroyd type are properly gas engines, the gas being formed by the vaporization of oil. In the Diesel engine vaporization takes place in connection with compressed air cooled before being mixed with the oil. The combined charge of oil and air is then injected into the engine cylinder where it meets the air of this cylinder compressed by the returning piston. By this compression the air is heated to such a point as to ignite the mixture of fuel oil and air, and this burns, propelling the piston forward. With the Hornsby-Akroyd engine, the oil is injected directly into a vaporizer connected to the cylinder of the engine, and an explosion takes place when the returning piston compresses the air mixing it with the fuel oil, the mixture being heated by the heat of the cylinder walls together with the heat of compression. The Diesel engine uses at full load approximately 1/11 of a gallon of fuel oil per brake horse-power per hour. The Hornsby-Akroyd engine uses approximately 1/8 to 1/9



TYPICAL INSTALLATIONS OF THE DIESEL ENGINE.

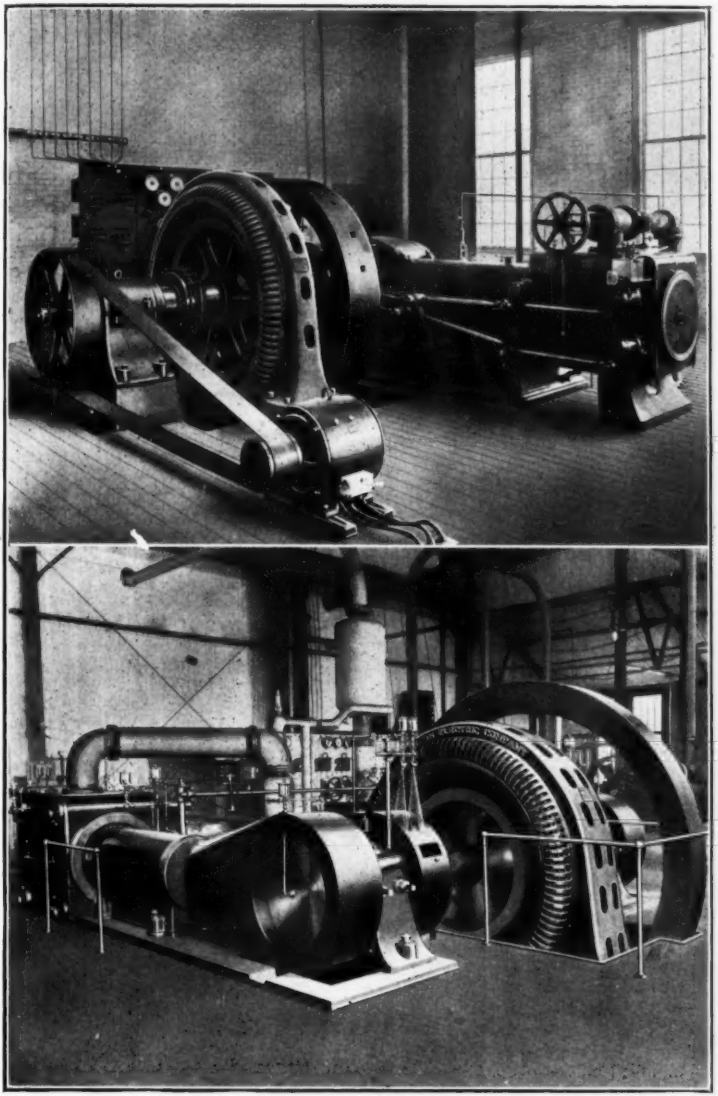
The upper view shows two units of 170 brake horse power each, coupled to 120-kilowatt G. E. direct-current generators, 200 revolutions, in the Traction Terminal Building, Indianapolis. The lower shows the Kimberley & Clark Paper Mills, auxiliary to water power; one unit of 450 horse power with 300-kilowatt generator. two of 225 with 150-kilowatt generators, and one of 120 driving engine compressors. The American Diesel Engine Co.

of a gallon of fuel oil per hour. As to which of these types of engines be used, the question of cost of fuel and cost of apparatus must be considered in each case in order to arrive at a decision. The Hornsby-Akroyd engine is somewhat simpler and less expensive than the Diesel engine, but its guaranteed efficiency is also less.

After the question of the type of power-generating apparatus has been decided, the next important question is that of its application. The use of electricity for transmitting the power from the engine to the tool is gradually superseding other methods of transmission, except where large amounts of steady power are to be delivered to long continuous shafts, such as is the case with looms, yarn mills, etc. Wherever the apparatus driven works intermittently, or where it is spread out over considerable area, the electric drive offers so many advantages as to make its choice almost a foregone conclusion.

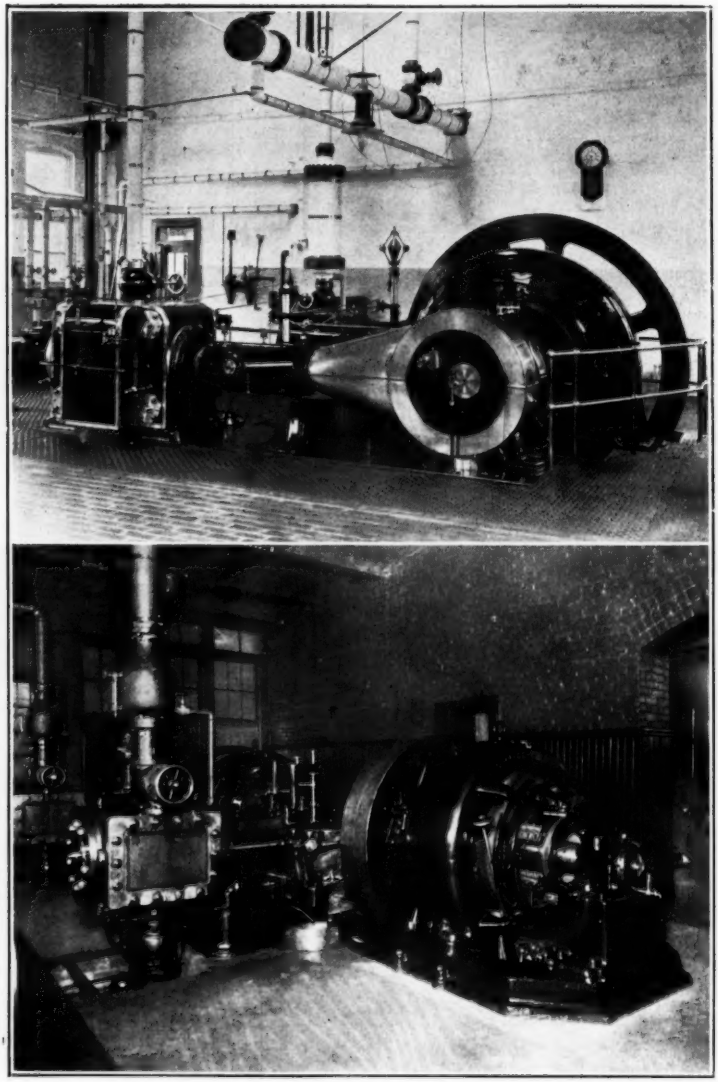
The question whether to use individual drive or group drive from a single motor is one that is not so definitely settled. The individual drive, if it were not for its expense, is preferable in all cases, as it allows adjustment of the operation of each machine to the need of the work and to the operator, and allows its location in any desired position; and when the apparatus is shut down no power is being used and none wasted in friction losses. Where there are a number of small machines or pieces of apparatus using but little power for each one, it seldom pays, however, to use a separate motor for each machine, and it is customary and advantageous to group a number of small machines around a single countershaft and drive this shaft from a motor. The electric drive offers the further advantage of ready metering, and this is particularly important where the building is occupied by more than one tenant and it is desirable to sell the current used either at cost of so much per horse-power per year or at the usual meter rates, so much per kilowatt per hour. With the old system of belt drive it was difficult to tell how much power a tenant (or a department) was using, an dthe results were neither fair to the user nor to the supplier of power.

If electric drive is used the question immediately arises as to whether the current supplied shall be alternating or direct, and, if direct, whether at 120 volts or 240 volts. For most factory work the direct-current motor with its easily variable speed, its large starting power, and its small starting current, is preferable to the alternating-current motor. The special field of the alternating-current motor is for continuous service and for locations where possible sparking at the brushes may be dangerous, or where dust and dirt are liable to accumulate and damage the motor.



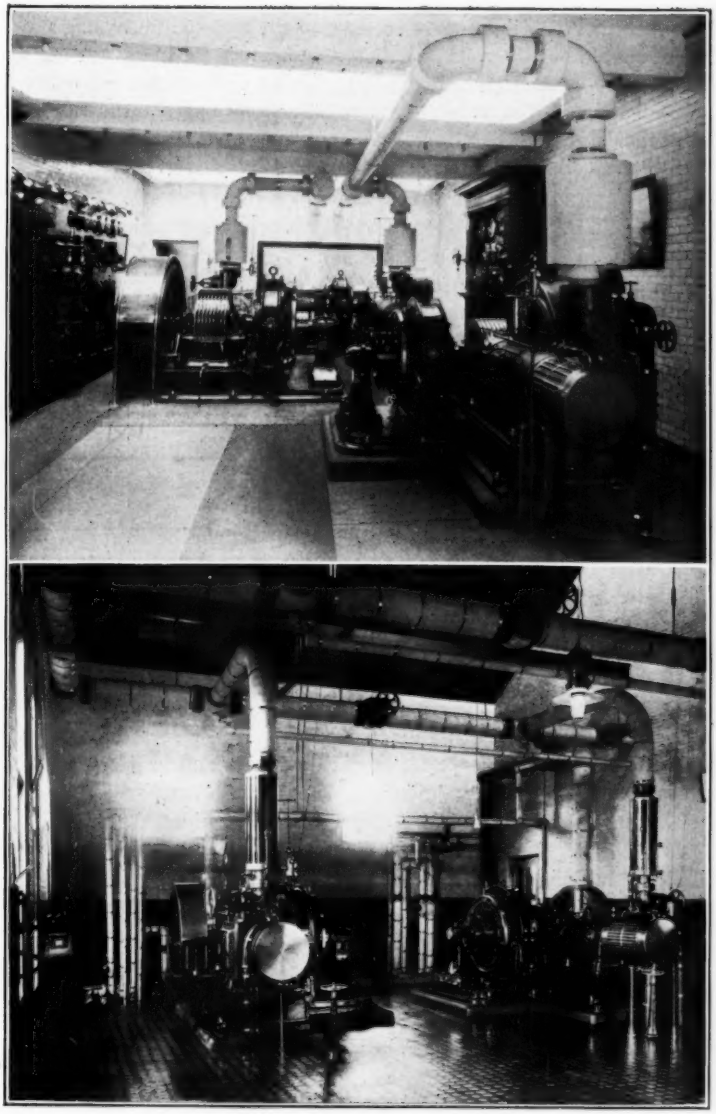
ALTERNATING CURRENT ELECTRIC-GENERATOR INSTALLATIONS FOR FACTORY POWER PLANT.

The unit above is a 200-kilowatt 240-volt 3-phase alternator at the Eagle Tanning Co., Grand Haven, Mich.; that below is an alternator in the plant of the Hecla Portland Cement Co., Bay City, Mich. Both installed by the Western Electric Co.



ELECTRIC GENERATORS IN STEAM-DRIVEN MANUFACTURING PLANTS.

The upper picture shows Crocker-Wheeler 200-kilowatt 250-volt generator driven by Hewes & Phillips engine at the Patton paint works; the lower one shows two 75-kilowatt 125-volt Crocker-Wheeler generators driven by Ball engines at 275 revolutions, Sheriff Street Market & Storage Co., Cleveland, Ohio. The Crocker-Wheeler Co.



MODERN ELECTRIC GENERATING SETS.

Above, 50 and 100-kilowatt units in the store of John C. Haynes, Boston, Mass. Below, two 75-kilowatt units at Dartmouth College, Hanover, N. H. Both are McEwen engines and Thompson-Ryan dynamos, installed by the Ridgway Dynamo & Engine Co.

If there is much lighting to be done in the factory, the voltage to be used should be 120 volts. If there is not much lighting, 240 volts is preferable, as it reduces the cost of feeders, and the switches are not so expensive. The 120-volt system means more substantial motors and switches, and all parts are heavier than for the 240-volt system, so that unless the cost of feeders is sufficiently greater on the lower voltage system to make the saving an object, the 120-volt motors are preferable, and they will be found to give much less trouble in operation than the higher voltage motors. This is due partly to the fact that there is a smaller difference in pressure existing between adjacent commutator segments on the motors, and also because the size of the wire used in the winding of the fields and in the winding of the armature on the lower voltage motors is four times as heavy as the wire used on the higher voltage motors.

In general, therefore, the equipment for a small factory would be designed for 120 volts, unless special conditions should make the use of alternating-current motors advisable, in which case the voltage would be 200.

With any type of plant described in this article the operation is comparatively simple, but it is important that some record should be kept of the operation, so that wastes may be checked before they have gone too far and (what is perhaps more important) to have the engineer in charge of the plant familiar with the quantities of electricity supplied, steam used, and the amount of fuel required to produce these quantities of steam and electricity. The records should include some hourly system of records, similar to a ship's log, to insure that someone is attending to business at least once an hour, and to prevent any continuation of wrong conditions, which might otherwise pass unnoticed until they had resulted in damage to the equipment.

On page 925 is shown a simple log blank for a small factory building containing one unit, and others for more complex plants will be found in an article entitled "Systematized Operation of Isolated Plants" which appeared in THE ENGINEERING MAGAZINE of December, 1903. These give all the essential information, and if summarized weekly or monthly would prove a valuable aid in maintaining the plant at its best efficiency. Such records should be supplemented from time to time by indicator cards of the engines, and by special reports on electric lamps and other supplies used in the plant. On page 926 a blank showing the method adopted in some plants to keep track of the electric lamps used and allow a comparison of the life of various makes is shown. Similar forms can be gotten up for packing and other supplies, but no attempt has been made in this

DAILY LOG OF POWER PLANT

Time	Amp's	Volts	STEAM PRES.	BACK PRES.
7 A.M.	60	230	90	2½
8	210	"	"	"
9	250	"	"	"
10	230	"	"	"
11	200	"	"	"
12 M	170	"	"	"
1 P.M.	200	"	"	"
2	230	"	"	"
3	220	"	"	"
4	240	"	"	"
5	260		"	"
6	70			
7	2370			
8				
9				
10	2270			
11				

SUMMARY 11-28-06

METERS	EDISON LIGHT	EDISON POWER		
Pres. Reading				Avg. Temp. Day
Prev. Reading				Kind of Day
Diff.				
Units				Cans Ashes 8
Rate				Qual. Coal
Cost				
	Quan.	Rate	Cost	Coal on Hand
Cyl. Oil				
Eng. Oil				
Greases				
Coal	5000		5.62½	
Gas				
Lamps				
Sundries				
Hell			6.35	
			11.97½	

Age

TIME SHEET

Employee	Arr.	Due
Engineer		
Fireman		
Elev.		

Machine	Start	Stop
Boiler 1		
Boiler 2		
Generator	6 55	6

REMARKS 538 K W H

The Eng. Magazine

LOG BLANK FOR POWER-PLANT DAILY RECORDS.

paper to take up the minor details which have so much to do with the success or failure of the plant, as such a discussion would involve a book rather than an article. The intention has been to present the problem confronting the designer of a factory equipment, and to show the more important factors which should receive consideration in determining the character of the plant. After the general design has been determined, the question of the comparative merits of different

types of furnaces, feed-water heaters, oil burners, pumps, steam and grease separators, engines, dynamos and motors, etc., is one to be settled by practical experience governed and directed by a knowledge based on the experience of others, commonly called theoretical knowledge. While not strictly germane to the subject of power-plant design, as a consulting engineer I may be permitted to use the engineering privilege of looking at all possible views of a matter, and a few words on the subject of so-called practical and theoretical knowledge may be in order.

— Lamp Record —

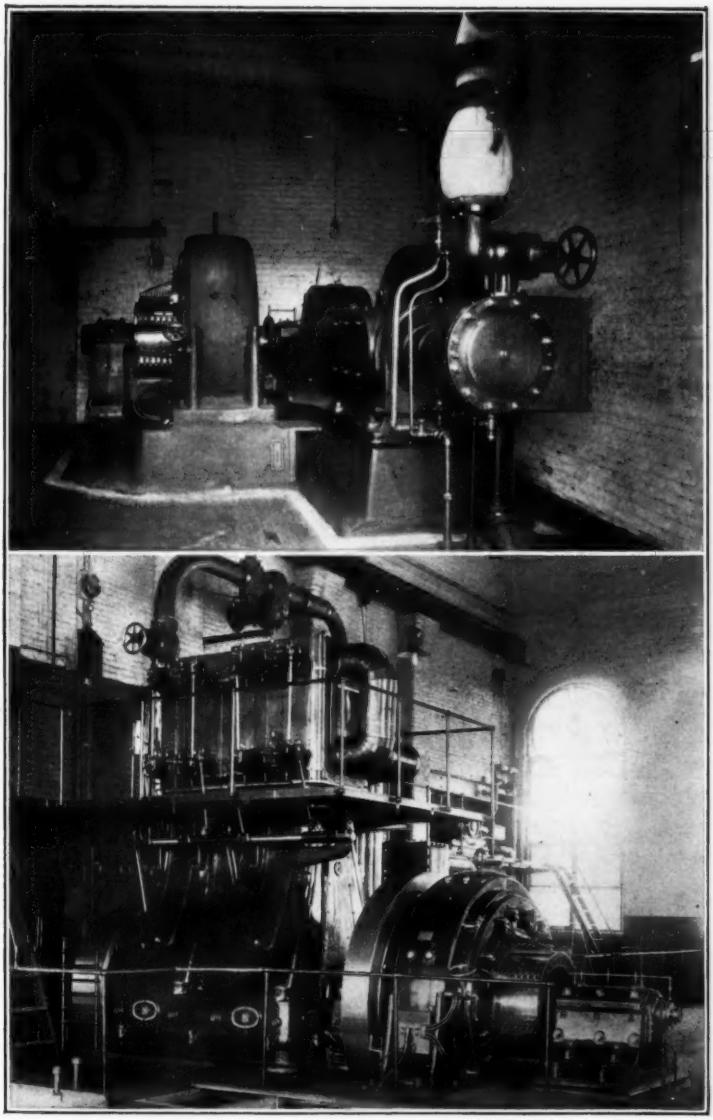
Lamp No.	C. P.	Make	Plain or Frosted	Watts	Put in	Replaced	Replaced	Replaced	Replaced	Replaced	Replaced	Replaced	Replaced

Lamp Voltage _____ Plant _____

The Eng. Magazine

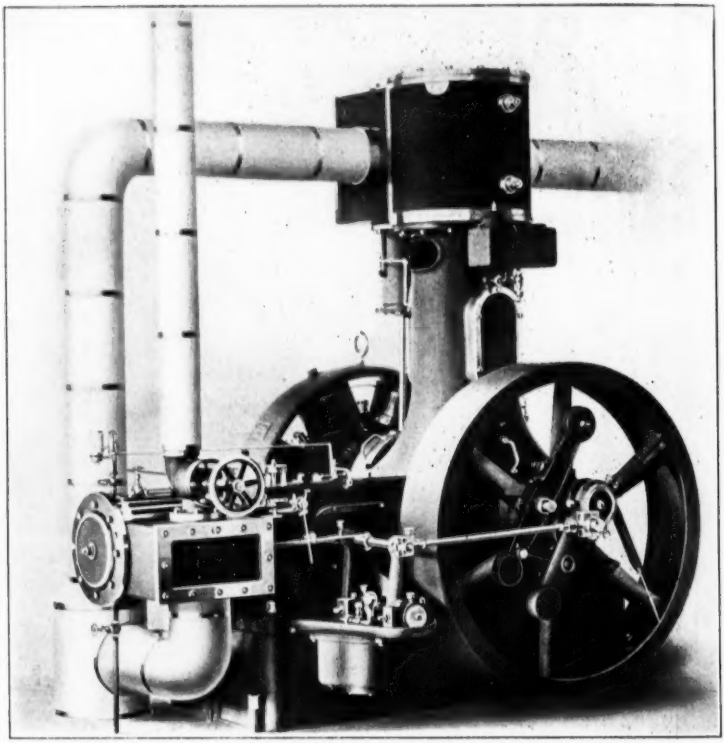
FORM FOR LAMP RECORDS.

By practical knowledge is meant the knowledge gained by personal experience, such as the knowledge the operating engineer gains of boilers and engines, or the electrician of wiring or motors, or the machinist of machine tools. Such knowledge is necessarily limited to the type and kind of apparatus which the engineer, electrician, or machinist has used personally, or has personally seen used. The highest grade mechanic is usually the one too who will hold a position the longest with one firm, being promoted from grade to grade, and it follows from this that his knowledge, exclusive of his theoretical knowledge gained from books, while perfect in respect to the apparatus used in his own plant, may be restricted as to apparatus used in other plants, particularly if these be working along different lines from his own; unless such practical knowledge is combined with theoretical engineering knowledge based on results obtained elsewhere, or on theoretical knowledge of the fundamental laws of mechanics and properties of materials, progress in design will be along very narrow lines.



STURTEVANT GENERATING SETS IN FACTORY INSTALLATIONS.

Above is a 150-kilowatt set supplied to the power house of the Thomas G. Plant Co. Below is a 250-kilowatt set with vertical cross-compound engine and 8-pole generator, at the Sturtevant works. Both by the B. F. Sturtevant Co.



AMERICAN-BALL ANGLE-COMPOUND STEAM ENGINE INSTALLED IN THE MANUFACTURERS' POWER PLANT.

The unit shown is of 160 horse-power, 300 revolutions, and is direct-connected to a 100-kilowatt American-Ball generator. Dimensions of the set: 112½ in. long, 112 in. wide, 117 in. high with wheel above the floor. Weight 21,000 lb.

Practical knowledge and theoretical knowledge may be compared to the horse and driver. A horse without a driver will find his way back to the stable and may be able to travel roads he has traveled before, but if new ways are to be gone over and new destinations arrived at, a driver with a knowledge of the conditions, obstacles, and comparative advantages of available roads must be looked to for guidance. We must look to the practical mechanic for the work of erection and manufacture, but the theoretical engineer is needed to plan the way to do the work to gain the desired end in the easiest and cheapest way—cheapest meaning "all things considered," and not "lowest in installation cost."

WATER FOR ECONOMICAL STEAM GENERATION.

By J. C. Wm. Greth.

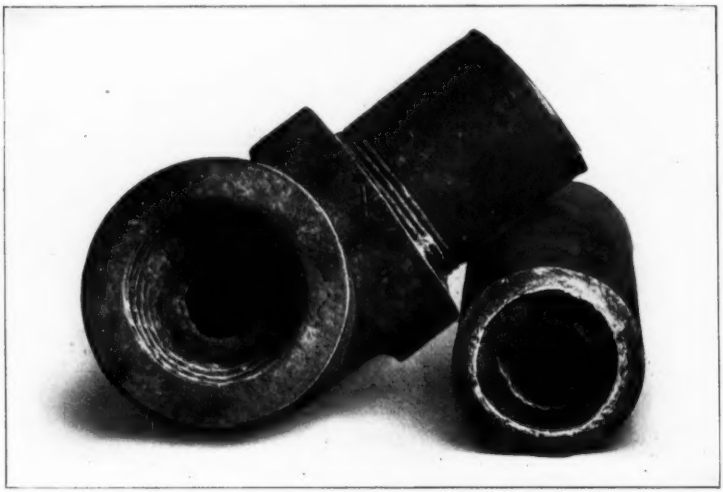
In an article published in the preceding issue of this Magazine, Mr. Greth presented a clear analysis and discussion of the relative purity of water supplies from various natural sources, and of the losses due to their direct use for boiler feed. The character and effect of the most conspicuous impurities were described, and an outline was given of the methods commonly followed to meet the difficulties in plant operation thus caused. The two types of water-softening system were indicated, and the results which an efficient system should secure were succinctly tabulated. Examples from the records of typical stations were shown to point out in the concrete the effect of the system advocated by the author.

In the pages following, this practical aspect of the matter is given precedence and a full showing is made of the actual savings effected in a large number of cases, the figures being proven wherever possible by complete records from the books, covering a length of time sufficient to assure true averages.—THE EDITORS.

A 3-INCH BOILER-FEED LINE REDUCED BY SCALE TO 1 INCH.

To supply the boilers working at 110 lb., the pump gauge registered from 160 to 175 lb. An open heater was in use.

SINCE our natural water supplies are such that boilers fed with them cannot be operated as economically as they should be, it is absolutely essential that means be taken to purify the water by removing from it such substances as interfere with the boilers being operated at the highest efficiency. Preventing the accumulation of scale by throwing the scale-forming substances into suspension in the boiler itself is only a make-shift. The offending material is still there and, by concentration, in an ever-increasing quantity, which cannot be prevented or removed by blowing off; even if no scale accumulates in the boilers they must frequently be opened to remove the collected sludge.



PART OF 1¼-INCH WATER-COLUMN LINE, OPENING REDUCED BY SCALE TO ½ INCH.
The water was supplied to the boiler through the line shown on the preceding page.

Since there is a method which will successfully purify water before it is fed into a boiler to prevent the accumulation of scale and corrosion, it will be apparent to anyone who has given any consideration to the economy of steam-boiler operation, or who has ever examined the bills in connection with it, that a water-softening system is an important factor in the economical generation of steam, where the water supply is not soft and clear and all that it should be. To determine whether a water-softening system would be a paying investment, let anyone operating a steam boiler compile figures showing the following:—

1.—Cost of city water.

2.—Cost of cleaning boilers.

3.—Cost of cleaning heaters, piping, and economizers.

4.—Cost of repairs.

5.—Cost of compounds.

6.—Cost of tube cleaners.

7.—Cost of fuel required to heat the boilers cooled for cleaning and repairs. (One ton of coal per 100 horse power may be used as an average figure for this calculation.)

8.—Interest and depreciation on spare or idle boilers. Against this should be figured for operation with a water-softening system the following:—

1.—Cost of pumping water (if city water is used in figures under item 1 above), which will vary from 1 mill to about 2 cents per 1,000 gallons, depending on the amount, type of pump, and distance pumped.

2.—Cost of softening water (can easily be determined from the analysis of the water).

3.—Cost of washing out boilers (once in six months with an efficient water-softening system).

4.—Cost of heating to steam boilers cooled for washing.

5.—Depreciation of 10 per cent; the investment may be taken roughly at $5.00 per horse power for plants up to 500 horse power; at $4.00 per horse power for plants from 500 to 800 horse power; $3.50 per horse power for plants from 800 to 1,250 horse power; and above this from $3.00 to $1.50 per horse power for plants of 6,000 horse power or greater. The above figures include foundations and ordinary connections.

6.—Interest on investment at 6 per cent.

The above does not take into consideration any saving in fuel. That a saving in fuel will be effected when using a clear, soft water as compared with the use of a water which forms scale, is beyond question, since with the clear, soft water the boilers will always be clean, while with an impure water, even though the boilers may be regularly cleaned, the amount of scale will vary from cleaning to cleaning, depending upon how thoroughly the cleaning is done; it is, however, practically impossible to clean thoroughly by mechanical means many of the various types of boilers now on the market, and if the prevention of scale formation is accomplished with boiler compounds there will not be obtained the same economy in fuel consumption as when the boilers are fed with a clear, soft water.

An absolutely safe figure for use in calculating the possible saving in fuel due to increased evaporation may be taken at 1 per cent. In other words, a boiler under average operating conditions which is regularly cleaned with tube-cleaning apparatus and with the use of a compound, evaporates 10 pounds of water per pound of coal; the boiler being clean all the time, the evaporation is increased to 10.1 pounds. This saving as compared with the figures already given is conservative, and perfectly safe for anyone to use who is investigating the subject to determine whether a water-softening system would be a paying investment. One of the largest steam users in the United States, who has gone into the subject of water softening to probably a greater extent than any other steam user, makes the

SCALE DEPOSITED IN A WOODEN TROUGH CARRYING HOT WELL WATER TO THE SEWER.
The sample is 3 in. thick and was 22 ft. long. The water had been raised to 110 degrees in ammonia and steam condensers.

statement that in one of his plants having an output of 40,000 tons of steel annually, he is saving 200 pounds of fuel per ton of product. This plant has 1,300 horse power boiler capacity. On the basis of 30 pounds of water per horse power per hour, when the boilers were regularly cleaned and compound used the evaporation was 6 pounds of water per pound of coal; with the water-softening system the evaporation was increased to 7½ pounds of water per pound of coal, or a saving of 25 per cent in fuel. The analyses before and after treatment are as follows:—

RIVER WATER.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter.	1.10	Volatile and Organic Matter.	.75
Silica	.25	Silica	.20
Oxides of Iron and Alumina.	.15	Oxides of Iron and Alumina.	.05
Calcium Carbonate	6.55	Calcium Carbonate	1.09
Calcium Sulphate	5.68	Calcium Sulphate	.22
Calcium Chloride	7.50	Magnesium Carbonate	1.07
Magnesium Chloride	3.21	Sodium Sulphate	5.97
Sodium Chloride	21.45	Sodium Chloride	30.50
TOTAL SOLIDS	45.89	TOTAL SOLIDS	39.85
Suspended Matter	2.35		
Free Carbonic Acid	.11		
Incrusting Substances	24.44	Incrusting Substances	3.38

To determine whether a water supply will prove to be a satisfactory boiler feed it is advisable not to wait for effects in the boilers, but to have a complete analysis made in order to determine the effect on the boilers and the purifying reagents to be employed in case treatment is necessary. The usual reagents are lime and soda ash; these are the cheapest known as well as the best adapted for the treatment of ordinary water supplies. The cost may vary in different localities, but lime at ½ cent per pound and soda ash at 1¼ cents per pound would be safe figures for nearly all parts of the United States.

The following analyses represent typical supplies taken from various sources through the United States (together with the analyses after treatment), with the cost of reagents (based on above figures) required for treatment to reduce the scale-forming substances to a point where experience has shown that the water will neither scale nor corrode boilers.

WELL—INDIANAPOLIS, IND.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter.	1.60	Volatile and Organic Matter.	.40
Silica	1.10	Silica	.27
Oxides of Iron and Alumina.	trace	Oxides of Iron and Alumina.	trace
Calcium Carbonate	12.96	Calcium Carbonate	1.39
Calcium Sulphate	10.54	Magnesium Hydrate	.65
Magnesium Carbonate	8.04	Sodium Carbonate	.11
Magnesium Chloride	2.41	Sodium Sulphate	11.21
Sodium Chloride	1.63	Sodium Chloride	4.65
		Sodium Hydrate	.30
TOTAL SOLIDS	38.28	TOTAL SOLIDS	18.98
Suspended Matter	.75		
Free Carbonic Acid	1.10		
Incrusting Substances	36.65	Incrusting Substances	2.71

Cost of treatment, 3.7 cents per 1,000 gallons.

WHITE RIVER—INDIANAPOLIS, IND.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter.	.80	Volatile and Organic Matter.	.11
Silica	.35	Silica	.17
Oxides of Iron and Alumina.	trace	Oxides of Iron and Alumina.	trace
Calcium Carbonate	10.37	Calcium Carbonate	1.63
Calcium Sulphate	6.80	Calcium Hydrate	.15
Magnesium Carbonate	3.51	Magnesium Hydrate	.27
Magnesium Chloride	.87	Sodium Sulphate	7.18
Sodium Chloride	6.68	Sodium Chloride	7.78
TOTAL SOLIDS	29.38	TOTAL SOLIDS	17.29
Suspended Matter	3.65		
Free Carbonic Acid	.44		
Incrusting Substances	22.70	Incrusting Substances	2.33

Cost of treatment, 2 cents per 1,000 gallons.

SECTION OF 10-INCH SPIRAL RIVETED EXHAUST OUTLET FROM OPEN HEATER.
Opening at heater reduced by scale to 2 in., tapering to full opening in 8 ft. Back pressure on engine increased from about ½ lb. to 8 lb.

MONONGAHELA RIVER—McKEESPORT, PA.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter..	.25	Volatile and Organic Matter..	.05
Silica	.55	Silica	.25
Oxides of Iron and Alumina.	.80	Oxides of Iron and Alumina..	trace
Calcium Sulphate	6.07	Calcium Carbonate	1.39
Magnesium Sulphate	2.88	Magnesium Carbonate	.74
Magnesium Chloride	.20	Sodium Sulphate	13.14
Sodium Chloride	.58	Sodium Chloride	.82
TOTAL SOLIDS	11.33	TOTAL SOLIDS	16.39
Suspended Matter	1.75		
Free Carbonic Acid.....	.88		
Free Sulphuric Acid.....	2.22		
Incrusting Substances	10.75	Incrusting Substances	2.43

Cost of treatment, 2 cents per 1,000 gallons.

NIAGARA RIVER—BUFFALO, N. Y.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter.	trace	Volatile and Organic Matter.	trace
Silica	1.85	Silica	.15
Oxides of Iron and Alumina..	trace	Oxides of Iron and Alumina..	trace
Calcium Carbonate	2.20	Calcium Carbonate	1.25
Calcium Sulphate	2.11	Magnesium Hydrate	.25
Magnesium Carbonate	.48	Sodium Sulphate	2.21
Magnesium Chloride	.05	Sodium Chloride	.80
Magnesium Nitrate	1.16	Sodium Nitrate	1.31
Sodium Chloride	.76		
TOTAL SOLIDS	8.01	TOTAL SOLIDS	5.97
Suspended Matter	.10		
Free Carbonic Acid	1.43		
Incrusting Substances	7.85	Incrusting Substances	1.65

Cost of treatment, .8 cent per 1,000 gallons.

BAD WELL WATER.

Raw.

	Grs. per U. S. Gallon.
Volatile and Organic Matter	6.10
Silica	1.05
Oxides of Iron and Alumina	trace
Calcium Sulphate	92.28
Magnesium Carbonate	10.31
Magnesium Sulphate	28.38
Magnesium Chloride	1.55
Sodium Chloride	.23
TOTAL SOLIDS	139.90
Suspended Matter	2.90
Free Carbonic Acid	1.00
Incrusting Substances	139.67

Treated with Lime and Soda Ash.	Grs. per U. S. Gallon.	Treated with Barium Carbonate, Lime and Soda Ash.	Grs. per U. S. Gallon.
Volatile and Organic Matter..	.75	Volatile and Organic Matter..	.35
Silica	.20	Silica	.15
Oxides of Iron and Alumina..	trace	Oxides of Iron and Alumina..	trace
Calcium Carbonate	1.85	Calcium Carbonate	1.96
Magnesium Hydrate	.45	Magnesium Hydrate	.55
Sodium Carbonate	.11	Sodium Sulphate	7.19
Sodium Sulphate	131.06	Sodium Chloride	2.14
Sodium Chloride	2.10		
Sodium Hydrate	.07		
TOTAL SOLIDS	136.59	TOTAL SOLIDS	12.34
Incrusting Substances	3.25	Incrusting Substances	3.01
Non-Incrusting Substances	133.34	Non-Incrusting Substances	9.33
Cost of treatment, 20.2 cents per thousand gallons.		Cost of treatment, 42.3 cents per thousand gallons.	

For the last analysis of raw water two treatments are shown. The water treated with lime and soda ash did not make a satisfactory

boiler water on account of foaming, so barium carbonate, lime, and soda ash were used with good results. This is the only available supply unless a pipe line were run some eight miles for a better one. It was found impossible to operate with the raw water on account of high cost of fuel and repairs.

ANOTHER BAD WELL WATER.

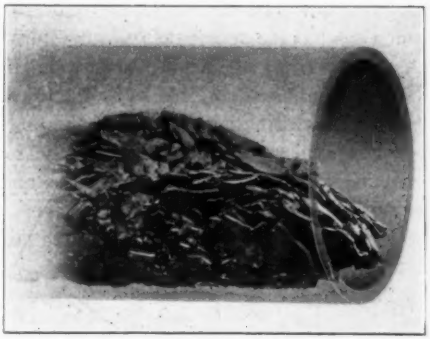
Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter..	1.05	Volatile and Organic Matter..	.35
Silica	2.10	Silica	.55
Oxides of Iron and Alumina..	.35	Oxides of Iron and Alumina..	trace
Calcium Carbonate	14.37	Calcium Carbonate	.75
Calcium Sulphate	62.90	Magnesium Hydrate	.52
Magnesium Carbonate	4.54	Sodium Carbonate	.48
Sodium Sulphate	31.95	Sodium Sulphate	97.70
Sodium Chloride	15.00	Sodium Chloride	15.00
Sodium Nitrate	5.59	Sodium Nitrate	5.67
		Sodium Hydrate	.09
TOTAL SOLIDS	137.85	TOTAL SOLIDS	121.11
Suspended Matter	1.55		
Free Carbonic Acid.....	1.65		
Incrusting Substances	85.31	Incrusting Substances	2.17
Non-Incrusting Substances ...	52.54	Non-Incrusting Substances ...	118.94

This water after treatment compares very closely in the total non-incrusting solids with the preceding water treated with lime and soda ash, which in that case could not be used on account of priming and foaming.

A BOILER TUBE ENTIRELY FILLED WITH SCALE.
No trouble from scale had been suspected until it was found necessary to remove more than 100 tubes like this.

Priming and foaming are brought about by conditions not thoroughly understood, and usually are attributed entirely to the water used. Experience, however, has shown that foaming is often the result of surface conditions in the boiler, and in nearly all cases can be directly traced to the presence of suspended matter, coupled with the condition of the boiler, the pressure and rate at which the boiler is operated, the type of boiler,

and the arrangement of steam piping. Clean boilers fed with a clear water practically free from scale-forming substances are not likely to foam. Foaming very often is attributed to the sodium salts which a water contains, and which cannot be removed by treatment. This may be true to a certain extent, but in the above case experience has shown that a water containing almost 119 grains of sodium salts per U. S. gallon, when fed into a clean boiler, did not cause priming or foaming. It will be noted that the scale-forming substances in the analysis shown above have been reduced to a low point, that the water is entirely free from suspended hatter, and that even with the concentration of the sodium salts no trouble from foaming or priming is experienced. This treated water is used in water-tube boilers, rated at 300 horse power each, operated at about 10 per cent above their rated capacity.



SCALE LOOSENED FROM TUBE BY BOILER COMPOUND, BUT CEMENTED AGAIN BY SCALE-FORMING SUBSTANCES IN THE FEED WATER.

Some soft clear natural waters corrode boilers on account of containing such substances as magnesium chloride and magnesium nitrate, as for instance the following taken from a well in Mississippi; this water, aided by its carbolic acid, causes corrosion due to the dissociation of the magnesium chloride into magnesium hydrate and hydrochloric acid, the alkalinity of the water being too low to fix the acid set free.

	Grs. per U. S. Gallon.
Volatile and Organic Matter	.25
Silica	.85
Oxides of Iron and Alumina	trace
Calcium Carbonate	.55
Calcium Sulphate	.27
Calcium Nitrate	.23
Magnesium Carbonate	.17
Magnesium Chloride	.23
Sodium Chloride	.30
TOTAL SOLIDS	2.85
Suspended Matter	.05
Free Carbonic Acid	1.32
Incrusting Substances	2.55

Cost of treatment, ⅓ cent per 1,000 gallons.

In some natural waters the scale-forming substances in solution, such as calcium carbonate, calcium sulphate, or magnesium carbonate, are not present to such an extent that they of themselves would form scale, but the presence of suspended matter in conjunction with them causes the formation of scale. This is due to the fact that the action of heat and the concentration of the soluble impurities form a precipitate that acts as a cement. The analysis of such a water, taken from one of the large American rivers, is as follows: Perfect clarification by sedimentation and filtration would make this an ideal supply.

RIVER WATER.

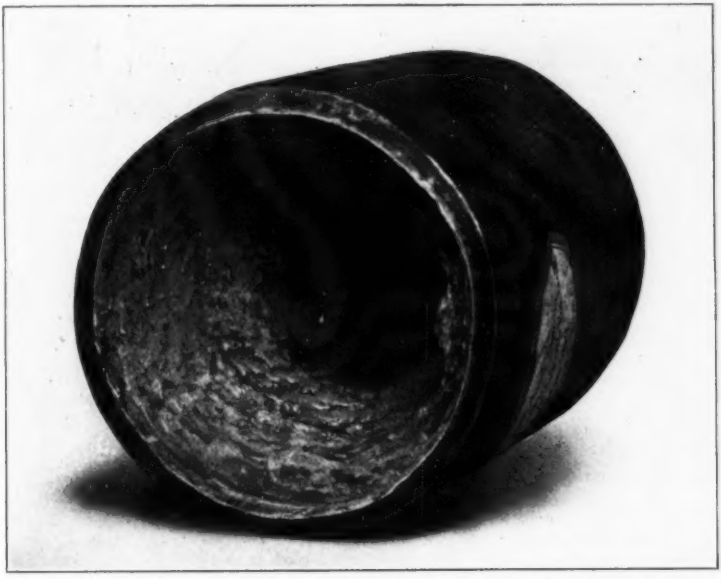
	Grs. per U. S. Gallon.
Volatile and Organic Matter	.75
Silica	.35
Oxides of Iron and Alumina	.25
Calcium Carbonate	.52
Calcium Sulphate	1.85
Magnesium Carbonate	.50
Sodium Sulphate	.11
Sodium Chloride	.33
Sodium Nitrate	.16
TOTAL SOLIDS	4.82
Suspended Matter	18.05
Free Carbonic Acid	.33
Incrusting Substances	4.22

The following analysis shows a supply which is quite common in some sections of the United States; it contains a considerable amount of scale-forming substances, but in actual practice boilers are operated from two weeks to a month without cleaning; no scale accumulates but a great deal of sludge is thrown down, which is removed by frequent blowing off and washing out. The formation of scale is probably prevented by the sodium carbonate. While this water does not form scale, better results would be obtained if the scale-forming substances were removed from it before being fed into boilers.

WELL WATER.

	Grs. per U. S. Gallon.
Volatile and Organic Matter	.85
Silica	.15
Oxides of Iron and Alumina	.15
Calcium Carbonate	9.29
Magnesium Carbonate	3.70
Sodium Carbonate	5.01
Sodium Sulphate	2.13
Sodium Chloride	3.96
TOTAL SOLIDS	25.24
Suspended Matter	.15
Free Carbonic Acid	.22
Incrusting Substances	14.14

I have in my possession a large number of statements of savings effected by different concerns by obtaining a proper water supply for boiler feed. On account of the wide difference in the methods of bookkeeping as well as in the records kept at various points, it is impossible to obtain a complete statement of the savings effected; but the savings of which record could be obtained in each case are sufficient to have warranted the investment, and to bring a return of the money invested in a comparatively short period of time. If all the savings that are actually effected are taken into consideration, in every case the investment in a proper apparatus for supplying the boilers with a clear soft water will, under average conditions, be returned within two or three years.



SECTION OF BOILER TUBE ORIGINALLY FULL OF SCALE, SHOWING DISINTEGRATION OF THE SCALE BY SOFTENED WATER.

The following statements are based on actual working conditions, and wherever estimates of figures were made it is so stated. In each case the analyses of the water are given before and after treatment. Of course all water supplies vary more or less and there will be some variation from the analyses given both in the raw and treated waters.

CASE I.

A 3,000 horse-power boiler plant located on the bank of a creek and buying city water. The city water on account of the quantity

used is obtained at 4 cents per thousand gallons, which is an exceptionally low rate. The city water contains free sulphuric acid at times, in addition to some scale-forming substances. The creek water is contaminated with mine drainage and is considerably harder than the city water. The analyses before and after treatment are as follows:—

CREEK WATER.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter..	.80	Volatile and Organic Matter...	.35
Silica	.55	Silica	.15
Oxides of Iron and Alumina..	.10	Oxides of Iron and Alumina..	trace
Calcium Carbonate	1.75	Calcium Carbonate	1.63
Calcium Sulphate	10.25	Magnesium Carbonate	.21
Magnesium Carbonate	3.40	Magnesium Hydrate	.38
Sodium Sulphate	1.44	Sodium Carbonate	.09
Sodium Chloride	4.79	Sodium Sulphate	12.17
Sodium Nitrate	.10	Sodium Chloride	4.91
		Sodium Nitrate	.11
TOTAL SOLIDS	23.18		
Suspended Matter	4.35		
Free Carbonic Acid.....	.44	TOTAL SOLIDS	20.00
Incrusting Substances	16.85	Incrusting Substances	2.72

OPERATING WITH CITY WATER.

88,720,000 gallons of water (taken from meter readings) per year, at 4 cents per 1,000 gallons.....	$3,548.80
Soda ash used as a compound, 60,000 lb. per year at 1 cent per lb...	600.00
Two men cleaning boilers throughout the year, at $45.00 per month each	1,080.00
Repairs, new tubes, patching and other incidental expenses due to bad water	1,790.00
	$7,018.80

OPERATING WITH WATER-SOFTENING SYSTEM TREATING CREEK WATER.

Softening 88,720,000 gallons of water per year (based on cost of reagents purchased during year).....	$1,552.60	
Cost of pumping 88,720,000 gallons of water at ¼ cent. per 1,000 gallons (estimated).....	221.80	
One man washing out boilers and looking after water-softening plant, at $45.00 per month (water tender operating water-softening system without interfering with regular work at night).....	540.00	
Interest at 6 per cent on investment of $5,700.00 in water-softening system	342.00	
Depreciation at 10 per cent on investment of $5,700.00 in water-softening system	570.00	3,226.40
Savings effected.....		$3,792.40

Or over 66 per cent on an investment of $5,700.00.

In the above statement it will be noted that the fuel saving is not taken into consideration because some of the boilers were operated

with the waste heat from the furnaces and fuel was used for other purposes than for steam generation; therefore it was impossible to obtain the cost of the fuel used for steam-making purposes only. The cost of pumping the water from the creek was estimated at ¼ cent per thousand gallons, which is believed to be ample.

CASE 2.

A 1,000 horse-power boiler plant operating 10 hours per day at about 900 horse power, 300 days a year, using city water (a natural supply of average quality).

CITY WATER.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter..	1.55	Volatile and Organic Matter..	.29
Silica	.35	Silica	.20
Oxides of Iron and Alumina..	trace	Oxides of Iron and Alumina..	trace
Calcium Carbonate	13.12	Calcium Carbonate	1.90
Calcium Sulphate	.61	Magnesium Hydrate	.60
Magnesium Carbonate	3.90	Sodium Sulphate	.71
Magnesium Chloride	1.30	Sodium Chloride	1.87
Sodium Chloride	.21	Sodium Hydrate	.08
TOTAL SOLIDS	21.04	TOTAL SOLIDS	5.65
Suspended Matter	.75		
Free Carbonic Acid.....	.10		
Incrusting Substances	20.83	Incrusting Substances	2.99

OPERATING WITH CITY WATER.

5371.2 tons coal at $1.87 per ton.....		$10,044.14
Boiler compounds per year, 3 kinds, 4 months, each kind:		
1,800 lb. at 9 cents lb.....	$162.00	
2,000 " " 6 " "	120.00	
1,200 " "12 " "	144.00	426.00
Repairs, new tubes, etc.....		219.00
		$10,689.14

OPERATING WITH WATER-SOFTENING SYSTEM TREATING CITY WATER.

4526.7 tons coal at $1.87 per ton.....	$8,464.93	
Total cost of reagents for softening water.....	251.00	
Depreciation at 10 per cent. on investment of $2,900.00..	290.00	
Interest at 6 per cent. on investment of $2,900.....	174.00	9,179.93
Savings effected.....		$1,509.21

Or over 52 per cent. on an investment of $2,900.00.

At this plant I was able to obtain from the books of the concern a complete statement of the fuel used. The year previous to installing the water-softening system at this plant, contracts had been made with several companies to furnish boiler compounds. Three different compounds were tried during the year. No labor charge is included in

this statement because the boilers were cleaned by the firemen, who were paid by the month.

CASE 3.

A 4,800 horse-power plant using a river water of about average quality, pumped by the plant. In this case again it was impossible to obtain a statement of fuel saving. One ton of coal per 100 horse power was used as a basis in estimating the amount of fuel required for heating to steam boilers cooled for cleaning. This, of course, also takes into consideration the heat lost due to cooling down the boilers.

RIVER WATER.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter..	2.16	Volatile and Organic Matter..	.60
Silica	.58	Silica	.25
Oxides of Iron and Alumina..	.30	Oxides of Iron and Alumina..	trace
Calcium Carbonate	4.67	Calcium Carbonate	1.25
Calcium Sulphate	5.31	Magnesium Hydrate	.55
Magnesium Carbonate	1.26	Sodium Carbonate	.25
Magnesium Chloride	1.20	Sodium Sulphate	5.55
Sodium Chloride	2.01	Sodium Chloride	3.50
TOTAL SOLIDS	17.49	TOTAL SOLIDS	11.95
Suspended Matter	2.11		
Free Carbonic Acid.....	.22		
Incrusting Substances	15.48	Incrusting Substances	2.65

OPERATING WITH RIVER WATER.

Cleaning twelve 400 horse-power Stirling boilers, one each week, 52 cleanings a year, two men 300 days a year at $1.37½ per day each	$825.00
Heating to steam 52 boilers 400 horse-power each, cooled for cleaning and repairs, 4 tons of coal per boiler, 208 tons at $1.40 per ton (estimated)	291.20
Repairs, new tubes, and incidental expenses, tube cleaners, etc., due to bad water	1,121.00
Boiler compounds, 48,000 lb. at 6¼ cents per lb.....	3,000.00
	$5,237.20

OPERATING WITH WATER-SOFTENING SYSTEM TREATING RIVER WATER.

Reagents for softening water (about .9 cent per thousand gallons)	$1,296.00	
Washing out one boiler every two weeks, 1 day for one man, 26 washings a year, 26 days at $1.37½ per day..	35.75	
Heating to steam 26 boilers cooled for washing out, 4 tons coal per boiler, 104 tons at $1.40 per ton (estimated)	145.60	
One-sixth man's time looking after softening plant at $40.00 per month.....	80.00	
Repairs, incidental expenses on boilers.....	219.00	
Depreciation at 10 per cent on investment of $7,200.....	720.00	
Interest at 6 per cent on investment of $7,200.....	432.00	2,928.35
Savings effected.....		$2,308.85

Or over 32 per cent on an investment of $7,200.00, without allowance for savings of fuel.

CASE 4.

A 2,000 horse-power plant shows the following expense for six months operation without water-softening system and for six months operation with water-softening system.

WELL WATER

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter..	.70	Volatile and Organic Matter..	.35
Silica	.85	Silica	.41
Oxides of Iron and Alumina..	trace	Oxides of Iron and Alumina..	trace
Calcium Carbonate	9.05	Calcium Carbonate	2.05
Calcium Sulphate	5.17	Magnesium Carbonate	.35
Magnesium Carbonate	7.31	Magnesium Hydrate	.57
Magnesium Chloride	.71	Sodium Carbonate	.11
Sodium Chloride	1.10	Sodium Sulphate	5.29
		Sodium Chloride	2.00
TOTAL SOLIDS	24.89	TOTAL SOLIDS	11.13
Suspended Matter	.30		
Free Carbonic Acid	.44		
Incrusting Substances	23.79	Incrusting Substances	3.73

OPERATING WITH WELL WATER.

Fuel	$14,718.40
Cleaning	864.44
Repairs	188.50
Incidentals	200.58
Labor	1,080.00
	$17,051.92

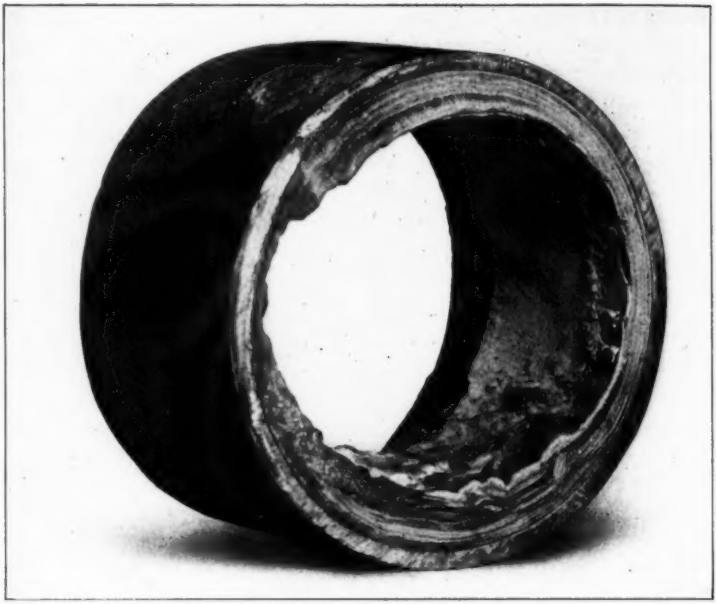
OPERATING WITH WATER-SOFTENING SYSTEM TREATING WELL WATER.

Fuel	$13,078.75	
Cleaning	40.00	
Repairs	94.00	
Incidentals	392.00	
Labor	1,080.00	
Interest at 6 per cent on investment (6 months)	112.50	
Depreciation at 10 per cent on investment	187.50	14,984.75
Savings effected		$2,067.17

Or over 55 per cent on an investment of $3,750.00.

CASE 5.

The statement given below is taken from a 450 horse-power boiler plant consisting of four 150 horse-power units, three of them being in operation all the time and the fourth being either cleaned or repaired From the cost of repairs that were necessary it is apparent that one of the boilers is in process of repair all the time. This plant is in operation at a coal mine, hence coal was not taken into consideration, as the plant owner does not realize that coal wasted under his boilers is



SECTION OF TUBE FROM A BADLY SCALED BOILER.

The hard scale has been loosened by the action of softened water.

worth to him that for which it could be sold. His principal reason for installing a plant was the cost of repairs. Each boiler was practically re-tubed every year.

WELL WATER.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter..	1.85	Volatile and Organic Matter..	.55
Silica	1.05	Silica	.12
Oxides of Iron and Alumina..	trace	Oxides of Iron and Alumina..	trace
Calcium Sulphate	30.60	Calcium Carbonate	2.11
Magnesium Carbonate	11.34	Magnesium Carbonate	.51
Magnesium Sulphate	2.15	Magnesium Hydrate	.70
Sodium Sulphate	4.39	Sodium Carbonate	.13
Sodium Chloride	1.81	Sodium Sulphate	38.78
		Sodium Chloride	1.80
TOTAL SOLIDS	53.19	TOTAL SOLIDS	44.70
Suspended Matter	.10		
Free Carbonic Acid.....	.55		
Incrusting Substances	46.99	Incrusting Substances	3.99

OPERATING WITH WELL WATER.

Boiler repairs, new tubes, and labor	$1,450.00
Cleaning boilers, two days each week, 52 cleanings a year, 104 days at $1.60 each	166.40
Cleaning heater twice a week (soda ash used in heater), 5 hours each cleaning, 52 days' labor at $1.60	83.20
Soda ash, 30,000 lb. at 1 cent per lb.	300.00
	$1,999.60

OPERATING WITH WATER-SOFTENING SYSTEM TREATING WELL WATER.

Boiler repairs (three new tubes)	$111.00	
Cleaning each boiler, 4 boilers, 4 times a year, 2 days each cleaning, 32 days at $1.60 per day	51.20	
Cost of treating water (about 4 cents per thousand gallons)	531.36	
Depreciation at 10 per cent on investment of $1,900	190.00	
Interest at 6 per cent on investment of $1,900	114.00	997.56
Savings effected		$1,002.04

Almost 53 per cent on an investment of $1,900.00.

CASE 6.

A 5,000 horse-power boiler plant located on the bank of a river and buying city water. The plant is a power station of a large street-railway system. The statement is taken from the power-house record for the month of March, 1905, and for the same month of the year 1906. The engines in this plant are run surface-condensing. When the boiler was fed with this condensed steam and city water for make-up, it was found necessary to use a high-grade mineral oil for the cylinders, because the removal of oil by skimming devices from the condensed steam (in order to fit the latter for boiler feed) is more completely effected with a pure mineral oil than with an emulsifying mixture containing animal or vegetable oil. This will explain the decided drop in the cost of oil per month. (See next page.)

RIVER WATER.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter..	1.10	Volatile and Organic Matter..	.55
Silica	.50	Silica	.50
Oxides of Iron and Alumina..	.15	Oxides of Iron and Alumina..	.15
Calcium Carbonate	5.70	Calcium Carbonate	1.07
Calcium Sulphate	1.73	Magnesium Hydrate	.36
Magnesium Carbonate	.88	Sodium Carbonate	.29
Sodium Sulphate	.32	Sodium Sulphate	2.09
Sodium Chloride	1.32	Sodium Chloride	1.35
TOTAL SOLIDS	11.70	TOTAL SOLIDS	6.36
Suspended Matter	3.35		
Free Carbonic Acid	.66		
Incrusting Substances	10.06	Incrusting Substances	2.63

	March. 1905.	March, 1906.	Increase.	Decrease.
Labor—				
Operating Expenses:				
Boiler Room	$500.30	$491.00	.....	$9.30
Boiler Repairs	61.71	37.50	.....	24.21
Material—				
Oil and Grease	388.66	183.79	.....	204.87
Water	126.14	66.68	.....	59.46
Purifying Water	.....	35.25	$35.25	.....
Total K.W.H.	1,156,975	1,305,897	148,922	.....
Total tons coal	2,385	2,231	.....	154
Lb. coal per K.W.H.	4.60	3.82	.....	.78
Cost coal per K.W.H.	$0.00339	$0.00305	.....	$0.00034
Expense per K.W.H.	$0.006	$0.00507	.....	$0.00093
Avg. tons coal per day	77	71.97	.....	5.03
Cost coal per ton	$1.47	$1.59	$0.12	.....
Cost coal per car per day	$1.92	$1.75	.....	$0.17
Cost oil per 1,000 K.W.H.	$0.336	$0.157	.....	$0.179

SAVINGS EFFECTED OPERATING WITH WATER-SOFTENING SYSTEM.

Boiler-Room Labor Saving		$9.30
Boiler Repairs, saving		24.21
Oil and Grease		204.87
Water		59.46
Fuel, 154 tons at $1.59 per ton		244.86
		$542.70
Cost of purifying water	$35.25	
Depreciation charge per month at rate of 10 per cent on $7,000.00	58.33	
Interest charge per month at rate of 6 per cent on $7,000.00.	35.00	128.58
Savings effected per month		$414.12
Savings effected per year		$4,969.44

Or almost 71 per cent on an investment of $7,000.00.

The above statements represent only average conditions and not by any means the worst, for often an entire power plant is shut down on account of the condition of the boilers, due either to the accumulation of scale or to the action of corrosive acids or salts.

It will be noted in the statements that 10 per cent for depreciation and 6 per cent for interest on the investment in the softening system have been allowed. As nearly as possible the actual cost of installing the system was obtained, which included the system itself, necessary foundations and connections. The life of a system of this character should be at least twenty years, so that the difference in the amount deducted for depreciation to take care of the cost of replacing the system will easily take care of the cost of repairs which may be necessary and for keeping it in proper condition.

It is a well-known fact that in changing the feed of a boiler from a hard to a soft water the scale becomes loosened, and that by the continued use of the soft water the boiler will in time become clean. The rate at which the scale will be loosened depends on its character and

thickness and the conditions under which the boiler operates. The removal of the scale usually occasions some expense on account of exposing defects in the boiler which had been covered by it; and further, the removal of the scale by the change of water is sometimes accompanied by foaming or priming due to the loosened scale being whipped fine by the disintegrating effect of the circulation of the water. These effects are not chargeable against the soft water, but are after-effects of the use of bad water, and with care and the continued use of soft clear water will entirely disappear.

The ideal supply for boiler feed is a clear, soft, natural water which will not cause an accumulation of sludge or scale, or corrode the boiler. In the absence of such a supply, the best thing to do is to change by chemical treatment an impure water into one which is clear and soft before being fed into the boiler, and not to resort to make-shift methods for the prevention of scale.

Our city supplies, as a rule, are as hard as supplies which can usually be obtained more cheaply by pumping. It is better, then, to soften and purify the supply which can be pumped. When a water supply is not clear, soft, and free from corroding substances, a water-softening and purifying system will always earn large dividends on the investment, allowing liberally for cost of maintenance, depreciation and interest.

A steam-plant owner will install boilers of the most improved design, with mechanical stokers, damper, and feed-water regulators, install feed-water heaters and economizers and the most economical engine obtainable; but the purity of the water—the most essential factor which enters into the cost of producing power—is often totally neglected, and as a result of using an impure feed water, only a partial economy can be effected in the operation of the entire plant. The steam boiler is the heart of the steam plant; from it extend the arteries conducting the vital fluid which sustains the activities of the whole plant, and upon its successful operation depends to a great extent the economy of the entire mechanical system. The limit of possible economy is much more distant in boiler than in engine practice, and the engineers of the future are likely to be employed more with the problem of conveying a larger number of heat units from the fuel to the water than with the problem of making a pound of steam develop more foot pounds of work. The first essential in economy of boiler operation is that the water, the medium for transforming the energy of the fuel into power, should be of such a quality that it will not interfere with utilizing the greatest number of heat units in every pound of fuel, at a minimum cost of boiler maintenance.

FEED-WATER HEATING FOR THE POWER PLANT.

By Sidney A. Reeve.

Professor Reeve may always be counted upon to be interesting, whether his argument leads along well established lines or whether, as in this case, he strikes across the boundaries of ordinary practice to open up new suggestions. The interest here for those who may not agree with the ideas advanced—or at least not without modification—is heightened by Mr. Bolton's appended criticism and Professor Reeve's rejoinder, giving to the whole the fulness of a professional discussion.—THE EDITORS.

IN power plants making any pretense to high efficiency, the method of preheating the boiler-feed is a factor of considerable importance. This is true not only because it bears upon the heat which the fuel must supply, per pound of water passing through the boiler itself, but also because it affects the temperature at which the gases leave the economizer and enter the stack.

Such power plants may be divided into three classes, viz:

1.—Factory power plants run non-condensing, using their exhaust for heating purposes in winter.

2.—Factory power plants run condensing, except to such a degree as receiver steam is used, in whole or part, for heating.

3.—Power plants run condensing at all times.

In plants of the first and second classes the prime feed-water problem lies in the oil in the radiator returns. This, of course, can be and is minimized by the use of oil separators, etc. But the danger of oil being carried into the boilers in quantity is always there, while there is the certainty at all times that the boilers are subject to a certain degree of fouling, with its sequel of correctives and repairs.

In plants of the first class the best treatment of the question is to use only fresh, clean feed water; but to pass it, before use, through a closed heater through which the condensed returns pass in the opposite direction. In some cases, of course, the cost of the fresh water may be prohibitive of this plant, but not often. As to the extra cost of the heater, that will usually be much less than the cost involved in caring for the oil and making the repairs which it entails. And finally, as to the lessened temperature of water-supply, that is slight; and if the heater be arranged to utilize the appreciable quantity of steam which the returns bring with them, and which commonly goes to waste, it will be still less.

In plants of the second class there can be no question as to the advisability of using only fresh clean water. In these plants the primary heater constitutes a free supply of feed water of from 100 degrees to 125 degrees temperature. The primary heater is in reality a little preliminary surface-condenser. If the warm oily returns from the heating system be thrown to waste, and fresh cold water be run through the primary heater to the full amount needed by the boilers, the only penalty incurred is the purchase of a somewhat larger primary heater. The fresh supply of hot water is had without cost in the shape of fuel.

Incidentally, too, there is some reduction of load upon the condenser. Indeed, in plants working under a highly variable load, this latter feature may be of considerable value, in helping to take care of temporary overloads without spoiling the vacuum.

The same remarks are of course even more applicable to plants of the third class. No hot-well water should be used, except when the cost of a fresh supply of clean water is prohibitive.

From the primary heater the feed water should always go direct to the economizer. If it be replied to this that the economizer is not a fit piece of apparatus, constructively, to handle water of this temperature, it still remains true that the water from the primary heater "should" go there. In many cases economizers are handling cold water successfully. In every case they ought to do so. It is the prime object of the economizer's existence to cool the chimney-gases; and this it cannot do effectively if supplied with hot water.

From the economizer, or from the primary heater if there be no economizer, or from the original supply if there be no primary heater, the feed water should enter a closed heater and be heated by exhaust-steam from the pumps *under heavy back pressure*. The pumps should never exhaust into and through a heater under atmospheric pressure.

The policy of using direct-acting, non-expansive types of pumps is established in the United States beyond question. This policy needs no criticism, *provided* the pumps be used under the right conditions.

The correct conditions for efficiency in non-expansive working are a very slight range of pressure and temperature within the pump cylinder. For instance, engineers are now familiar with the idea that reciprocating engines, even when working expansively and compounded, cannot profitably lower their exhaust pressure below 24 inches to 26 inches of vacuum, corresponding to temperatures of 125 to 140 degrees Fahrenheit. Yet the turbine can go profitably far below this region.

Similarly, the direct-acting steam pump is a type which improves its efficiency only slightly as its back pressure is lowered. Indeed, it soon reaches a point where a lower back pressure is a positive harm. This point varies with the boiler pressure, of course, and with the design of pumps; but assuming an efficiency of action within the pump of 50 per cent, the following table gives the most profitable back pressure for a pump fed under several different boiler pressures:—

Boiler-pressure	120	150	180	250	lb. by gauge.
Best back-pressure..	7 inches vacuum	0	4	13	" " "

This, of course, is based upon a consideration of merely the efficiency of the pump itself. But the heat in the pump exhaust furnishes temperature to a much larger quantity of water than merely that finding entrance, as steam, to its own cylinders, and thus determining its own efficiency. The pump exhaust is useful for feed heating, and the hotter this feed can be gotten the better.

There is no limit to this last statement. The boiler will work at its best efficiency when the entering feed is at steam temperature. The pump will work, in one sense, at its best thermodynamic efficiency when its exhaust temperature is close to its admission temperature. The entire plant will work at its best efficiency when no heat escapes unused.

All these considerations point the wisdom of placing a heavy back pressure upon the heater into which the pumps exhaust, as near to boiler pressure as may be practicable; and then of running the pump on a virtually wide-open throttle, releasing the heater drip if more speed be desired.

The usual practice in pump operation is to throttle the available boiler pressure to a small fraction of itself at the pump admission. If the pump is to work under this greatly reduced effective pressure it is far better that the throttling be done on the exhaust, giving the plant the benefit, in its feed water, of the temperature range ordinarily lost in the throttling, than that it should be done on the incoming steam.

The limit to this practice, of course, is the ability of the feed water to condense the pump exhaust in the heater; and this in turn depends upon the temperature of the water entering the heater. If the back pressure be placed too high (and the pump steam-cylinder be made big enough still to provide sufficient power) the pump will exhaust more steam than the feed water can condense. If it be placed too low, the pump will be too efficient; it will pass so little steam that the feed

water will enter the boiler colder than it might, with the same consumption of fuel.

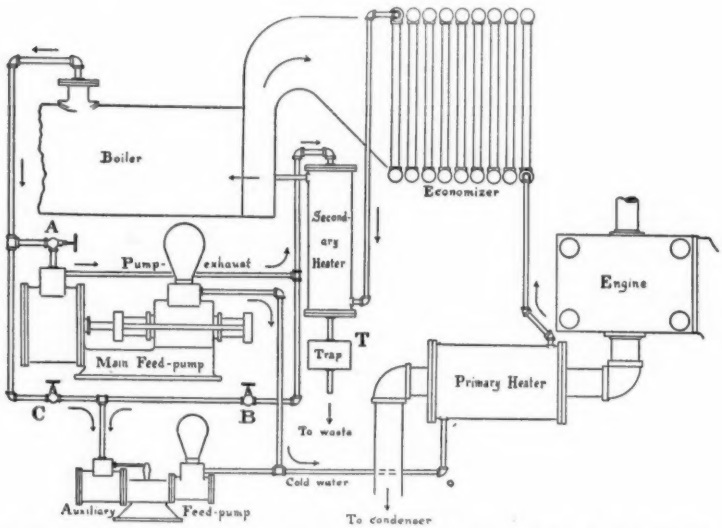
Assuming a temperature of discharge from the economizer, or of entrance to the secondary heater, rather, of 250 degrees F., and allowing a temperature-difference between steam and water in the heater of 20 degrees, the following table gives the figures suited to several different boiler pressures:—

1,000-Horse Power Plant. 18,000 Lb. Feed-Water per Hour.					
Boiler pressure, by gauge	120	150	180	250	lb.
Proper dimensions for duplex steam pump, the same for all boiler pressures, no extras being allowed for	16 — 4¼ x 12 inches				
Back pressure on pump	102	130	157	222	"
Pressure difference	18	20	23	28	"
Pressure difference required to balance boiler pressure on plunger	8½	10½	13	18	"
Temperature of boiler steam	349	365	379	406	deg. F.
" " pump exhaust	339	355	369	396	" "
" " feed water entering boiler.	319	335	349	376	" "
Probable weight of pump steam per 1 lb. of feed water, pump being in good ordinary condition	0.083	0.103	0.120	0.156	lb.

It is one of the happy coincidences of this plan that the varying pressure- and volume-effects, as the boiler pressure varies, work out to such a nice balance that the same proportion of pump cylinders will lead to the same temperature drop from boiler steam to pump exhaust, namely 10 degrees, and so to the same discrepancy between boiler temperature and feed temperature, namely 30 degrees, for all boiler pressures.

The natural arrangement of apparatus is shown diagrammatically on the next page. The system is controlled primarily by the set of the discharge trap T from the secondary heater, which should be adjustable so as to maintain automatically different back pressures in this heater. It is also controlled by the valve A. Since the effective pressure on the pump piston needed to produce motion is only some 10 to 20 pounds, while the difference between boiler and back pressures is to be not over 20 or 30 pounds, comparatively little throttling will suffice to control the pump over all ranges of speed ordinarily needed. Normally the valve A is expected to be left wide open.

For sudden and wide changes of load these methods of control are too sluggish. This objection is met by the adaptation of the usual auxiliary or relay pump, provided for emergency, to the needs of regulation. This pump is of ordinary dimensions. Should the main feed pump go out of commission, the relay pump may be supplied with boiler steam through the valve C, whereupon it throws cold feed



DIAGRAMMATIC ILLUSTRATION OF THE PROPOSED ARRANGEMENT FOR FEED HEATING.

water into the same circuit as the main feed pump. But this connection is for use only when the main feed pump is out of commission.

For purposes of regulation this auxiliary pump is also piped to receive back-pressure steam from the exhaust of the main pump, through the valve B. Should a sudden demand for feed exceed the ability of valve A and trap T to pick up the speed of the main pump sufficiently, the opening of valve B both accelerates the main pump and augments its water capacity by the addition of that of the auxiliary pump.

The degree of saving which such a system should make over the ordinary arrangement is impossible of computation. The only source of saving directly visible is that due to the lowered temperature of chimney gases, due to colder water in the economizer. The second saving is that much discussed and incomprehensible, but real and unquestionable, one due to feeding the boiler with water of its own temperature, even when the feed heating is done with live steam.

The third saving is the still more elusive, but none the less important, one involved in lessened wear upon the boilers, due to the absence of cold water from their interiors. It is such practical considerations as these, rather than refinements in fuel efficiency, which support the advocacy of this system.

THE ARGUMENT FOR THE OPEN FEED HEATER.

A DISCUSSION OF PROFESSOR REEVE'S PROPOSALS.

By Reginald Pelham Bolton.

As explained in the introduction to Professor Reeve's article, Mr. Bolton's comment was prepared at the invitation of the Editors.

THE author of the foregoing paper appears to have an exaggerated conception of difficulty in eliminating oil from the exhaust of engines. I have found no such difficulty, where a properly proportioned and properly drained oil separator is provided; and where loads are very variable, I have secured complete freedom by placing the separator in series with an open feed-water heater.

The only case of a failure of boiler tubes by reason of oil from the returns of radiators, in plants with which I have had to deal, was one on Broadway, which was provided with a closed feed heater and oil separator improperly drained.

Fresh water has in it more sources of danger to boilers than oil in the returns. The open feed heater receives and deals with the make-up water, and even where fresh water can be had for nothing, the arrangement of returning part of the exhaust in the form of direct condensation has the advantage. The author must have some unusually defective systems in mind when he speaks of the cost of "making the repairs" which oil entails. I have plants which have been running twelve years with open feed heaters without a cent of expense for such a purpose having been entailed.

As to plants of the second class, that is run condensing, using receiver steam for heating, there is no less advantage in the open feed heater; in fact, the combination is precisely that of marine practice, when the open feed heater is standard and successful.

As to class three, I would refer to my paper before the American Society of Heating and Ventilating Engineers, 1905, "Steam Heating in Connection with Condensing Engines," in which I gave the results obtained from a primary heater on the exhaust of a triple-expansion high-pressure cylinder in my Milburn test of 1904.

The increase of temperature is very limited with these heaters, as the most that can be secured is to catch part of the difference in

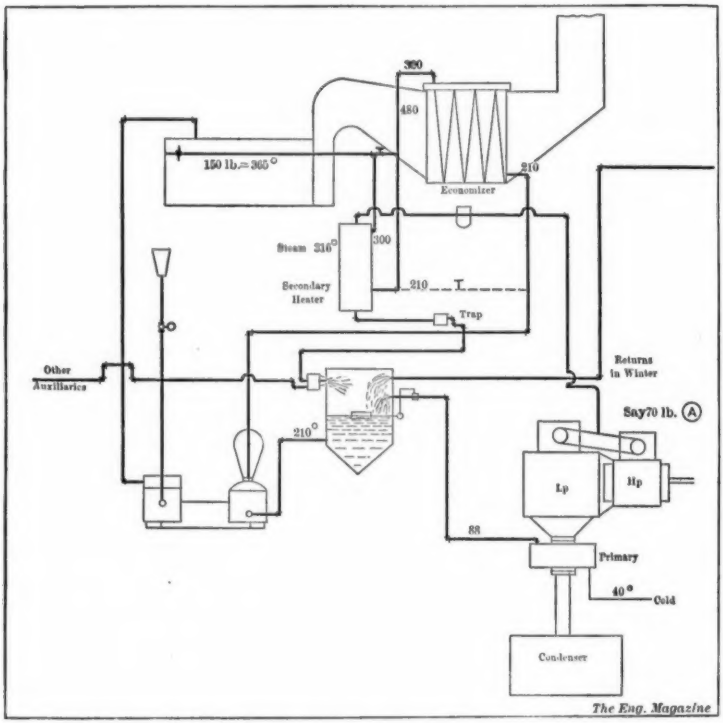


DIAGRAM ILLUSTRATIVE OF MR. BOLTON'S ARGUMENT.

Showing that the second heater is unnecessary with the economizer.

temperature between the exhaust at the opening of the valve, and the average of the condenser temperature. Under the circumstances noted the increase did not exceed 60 degrees F. and averaged only 48 degrees.

The plan proposed and shown in diagram on page 952 does not appear to me to be practical. In the first place, the primary heater does not drain. The only relief for the secondary heater is the trap, and it would require an extraordinarily nice balance of steam cylinder to heating surface and feed to prevent its backing up the condensation to the pump.

A direct-acting pump will short-stroke severely with an excessive back pressure such as proposed, and the pump would waver about its center of motion while its cylinder losses would be excessive.

All the heat in the trap discharge of superheated water goes to waste, as well as the exhaust of the auxiliary pump whenever that should be used.

Better results would be attained by the well-known Scotch marine system of taking the steam supply for the feed pumps from the first receiver and discharging and condensing its exhaust in the open feed heater.

The feed supply can usually be taken by gravity through a primary heater to the open heater.

The arrangements shown in the sketch on page 954 indicate that, where a temperature of 210 degrees can be reached by the exhaust of auxiliary machinery, there is little to be gained by the primary heater.

Further, where an economizer is desirable and is fed from an open (or closed) heater with water at or near 210-212 degrees, the output temperature is so near the boiler temperature that a secondary heater would effect little if any increase. If a secondary heater, rather than an economizer, be desirable, then the steam for its work may best be borrowed from the intermediate receiver or steam chest, which steam has already done its major work in expansion.

There is no great advantage in, or need for, the introduction of feed into boilers at the steam temperature; for first, such a temperature cannot be gained without economic loss either in flue gases or in steam used for the purpose, and, second, a moderate difference in temperature increases the effectiveness of heat transfer and promotes circulation.

Professor Reeve, being invited by the Editors of THE ENGINEERING MAGAZINE to make rejoinder to Mr. Bolton's comment, closes the discussion thus:—

> "Mr. Bolton and myself are obviously writing of different things. He is writing of a machine, of which the illustration is taken as a working drawing. I am advocating a policy, of which the illustration is a diagram. The arrangement as presented may quite likely develop some of the objections he mentions. But it is supposed to be the office of the engineer, if the pump kicks or the heater will not drain, to correct those incidents by a modification of previous practice, rather than to abandon his basic plan of design because of these insignificant features.
>
> "The crux of the whole article—the question whether it were better to feed our boilers with steam-hot water, and whether it were better to do it by live-steam heating or by the plan suggested—Mr. Bolton quite ignores. To him, as I understand him, 212-degree feed from an open heater is hot enough. The author finds in Mr. Bolton's remarks no reason for modifying his previous dissent from this view."

LABOR-COST DISTRIBUTION AT THE GENERAL ELECTRIC SHOPS.

By George Frederic Stratton.

WHEN eleven-thousand workpeople are paid $150,000 for their previous week's exertions upon a great variety of operations resulting in a great variety of products, it seems almost incredible to one not familiar with the highly systematized methods of great industrial corporations that the manager should receive, within a day or two, a detailed statement of exactly what every dollar of that money was paid out for. Upon that statement he can see, to a cent, how much has gone into production, construction, and expense. And these three classes are subdivided sometimes to an extraordinary degree. From that statement he knows the amount expended upon a single piece of apparatus, or a total expenditure upon some one great class of manufacture. He knows how many dollars and cents the handling of materials and supplies about the plant has absorbed, the cost of sweeping up the shops or any particular shop, or of clearing away a snow-fall.

To divide and charge up a heavy pay roll properly requires a system which shall be simple without sacrificing one iota of comprehensive detail; shall be economical without neglecting the keenest supervision and correct distribution of the various items. The system in use by the General Electric Company is most interesting, both for the large sums involved and the minute subdivision of those sums into their proper debits. At its Lynn (Mass.) plant there are eleven-thousand employees drawing a total of $150,000 weekly, including salaries. About one-third of these hands are on day work, the others on piece work. As this plant manufactures over five-thousand distinct varieties of articles, large and small, the number of operations is enormous, over twenty-thousand piece-work prices being in operation. The foundation upon which the entire system rests is the shop order. No service performed in these works is commenced without an order being issued first and a number assigned. Outside of the clerical force, every man, whether he be engineer or lumper, draughtsman or furnace man, piece worker or day worker, works under some distinct, numbered, written order.

The system of numbering appears complex in description, but is really simple when understood. The figure which stands for hundreds of thousands also stands for one of six great classifications. Thus, orders numbered 100,000 always relate to production; 200,000 to construction; 300,000 to repairs; 400,000 to expense; 500,000 to experimentation, and 600,000 to engineering, and draughting. But there is much subdivision of these classes, and to meet this the numbers are further systematized. On production orders the first figure indicates the class (production) the second and third the subdivision, and the last three the particular variety of apparatus or the special machine required.

For example: in the order 127,436 the figure 1 shows at a glance that it is a production order; the figures 27 show that it belongs to the division of railway motors, and the last three figures are the distinguishing numbers by which some peculiar type or size of motor is required. The subdivisions of production all relate to some distinct class of apparatus, as dynamos, railway motors, stationary motors, arc lamps, transformers, and so on. There are about fifty such subdivisions.

The construction orders relate to the erection of new buildings, the making of special tools, and everything which in any way increases the value of the plant or the equipment. The orders of this description always commence with the figure 2, thus showing instantly that construction is meant. The last five figures refer to the detailed instructions or plans of whatever construction is desired.

Repair orders refer entirely to repairs made by the company upon outside apparatus, or apparatus sent in for that purpose. As new parts are often used on such jobs, and as they always produce income, they are really "productions," and are treated as such in the yearly summary; but in the distribution of labor they are treated as a separate class. The first or indicating number is 3—the following numbers being, of course, an index to the particular job.

Expense is indicated by the number 4. Such orders are issued for all operations which are clearly operating expense—as running the steam plants, unloading cars and vessels, cleaning windows, etc. —all of which operations are again subdivided on the distribution of labor sheets, by being charged to the particular shop or department where the expense is incurred.

The number 5 relates to all work of an experimental nature—the making of new apparatus and the investigation and testing of appliances which may be purchased.

With number 6 we reach the engineering and draughting departments. As in the other classes, the five figures following refer to the special machine or instrument which is being designed or improved.

All these shop orders contain only such simple instructions as will enable foremen and men clearly to identify the work done with the number assigned. Form 1 shows this plainly. Detailed instructions are given separately to the foremen, accompanied by blueprints and specifications—all, however, bearing the same number.

Shop Order No. 168439

Mr. Lincoln

Date 8/7 - 07

Make 100 D.M. Railway Motors.

Duplicates to

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FORM I. SHOP ORDER.

The use of these numbers becomes apparent upon a consideration of the time cards and piece-work slips in use. The time cards are filled up daily by the workman. They must specify the times at which he commenced, or quit, upon any one job and must give the order number of the job, whether it be work on a lathe or firing a boiler—cleaning windows or melting steel. No matter what the time books (which are kept separately) say, no day-worker is credited on the pay roll with ten-hours work unless time cards showing ten-hours work, and upon what order it was spent, are turned over to the paymaster. These cards are O K'd by the foreman every night and sent to the paymaster each morning, and it will thus be seen that he receives, each day, vouchers or invoices (which they really are) for every hour of the previous day's labor.

Thompson-Houston Electric Co.

Workman's No. 4196 8/9 190 7

Name *John Smith*

Order No. 133924 Part

Assemble Motors

Commenced 9.15

Finished 5.30

Hrs. 5 Amt. 1 05

Rate 20 ¢ *The Eng. Magazine*

FORM 2. TIME CARD.

The piece-work slips (Form 3) are filled up by the workman in a similar manner, every day. They are O K'd by a regular inspector and sent to the paymaster on the following morning.

The story of the assembling of all these vouchers, or invoices, and the making up of the pay roll, does not properly belong to this

COMPLETED WORK SLIP

Thompson-Houston Electric Co.

West Lynn, Mass., 8/7 190 7

No. 7320 Name *H. Jones*

List No. Order No. 132924

Part No. 7 No. Completed 9

Oper. No. 14 Price { each 11 / per 100

Operation *Drilling Bases* Amount

Grand Total 99

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FORM 3. PIECE-WORK SLIP.

article. It is sufficient to explain that the clerks figure the time upon each time card and write the amount due upon that card (as shown) whether the time is for ten hours or for only one-quarter of an hour. The clerks in this department also check the piece-work prices upon the piece-work slips and figure up the amount due upon each slip.

It will thus be seen that, for every minute's service—either of day worker or piece worker—there comes into the office a written voucher which gives the number of the order under which the work was done, and the dollars or fractions of dollars claimed for such work.

After the pay roll is made up and all these vouchers are turned over from the paymaster's department to the distribution of labor department, they are found to have been arranged in the order of the workmen's numbers, so that credit for the amounts could be entered against each name on the pay roll. Now, however, a re-arrangement is necessary and is at once made by young clerks. The vouchers are sorted out according to the order numbers, and it is at this point that the peculiar significance of those numbers becomes apparent. First, sorting into the six great classifications by observing the first figure on each, the sorting into subdivisions is continued by means of the second and third figures. The work, which is of enormous proportions, is thus simplified and condensed.

The number of these little vouchers turned in weekly is very great. Frequently day workers will turn in five or six time cards in one day (every separate operation must be entered on a separate rate card). And on piece-work operations, although many men, working only on one operation, can enter their entire day's work upon one slip, there are so many minor operations in this plant—so many detail parts—that the average number of piece-work slips turned in by the workers is nine or ten each week. In all a total of over two-hundred thousand vouchers or invoices reach the Distribution of Labor department each week.

Sorted into neat bundles, with all slips bearing like order numbers assembled together, they reach the entry clerks, who add together all the amounts paid upon each order number, and enter the total in its proper place upon the "Labor Sheet."

A glance at Form 4 will show this method. The order number is at the left; the entries of the amounts paid to day workers and piece workers are made separately, and the total brought out to the right. Thus the manager can see, at a glance, the total amount spent upon Type C motors for the week, or he can find, by means

Distribution of Labor

Week ending *August 10' 07.*

Class	Order Number	Day Work	Hrs.	Piece Wk.	Hrs.	Total		Total Hrs.	Grand Total	
Type C. Motor	133024	321 17		1046 20		1367 37				
	133416	42 06		304 19		346 25				
	133633	86		208 17		209 03			1922	65
Arc Lamps	171303	178 24		394 20		572 44				
	171642	399 17		876 19		1275 36				
	171903	22 09		43 02		65 11			1912	91
Tool Expense										
Factory A.	410176	43 02				43 02				
" B.	410193	17 01				17 01				
" C.	410214	56 56				56 56				
" D.	410762	63 07				63 07			179	66
Helpers										
Factory A.	412205	33 06				33 06				
B.	412606	20 17				20 17				
C.	412337	170 43				170 43				
D.	412419	130 60				130 60			354	26
		1497 51		2871 97		4369 48			4369 48	

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FORM 4. DISTRIBUTION-OF-LABOR SHEET.

of the order numbers and reference to the original order, the amount spent upon any one variety of that Type C motor.

It is so all through the sheets. The subdivision of production has been mentioned. On expense it is carried out still more fully. Under "sweepers," for instance, there will be an entry for every separate shop in the plant where an individual sweeper is employed.

Under "tool expense" the same subdivision occurs, and so through all items of shop expense—they are separated by means of those order numbers and charged against the individual departments.

In all of the six great classes there are about one-hundred subdivisions, and generally one-thousand separate entries under all those subdivisions. That means that the entire force has been working under one-thousand different orders during the week. (It will be understood that these are not commercial orders. They are purely shop orders, many of them being "standing orders.")

In addition to the shop wages, the salaries of officials, clerks, and foremen are properly entered upon these labor sheets, with the result that the grand total balances the total on the pay rolls for the corresponding week.

In describing this system it may appear to be intricate and cumbersome, but it must be remembered that the amount of detail finally reduced to a few significant totals is very great. In considering it fairly one must even put aside the number of the hands and the amount of money paid out, and consider instead the vast quantity of items which must be handled to bring any result of value out of great confusion of record. For each one of those two-hundred thousand time cards and piece-work slips is really an invoice—complete in date, name of creditor, details of service rendered, and amount due and paid; and they must be so treated—unless the manager should be content simply to note the total amount of wages paid each week. And the value of this system, or one producing similar results, can hardly be estimated by any but those who have been connected with large aggregations of workers and have thus seen the continual utility and value of such statistics. Within a week following the payment of the wages there is placed before the manager a small slip of paper (Form 5) with seven totals written upon it. They are of Production, Construction, Repairs, Expense, Experimental, Engineering and the grand total of all these. Down in one corner is another little group of figures something like the following:—

Production	65 per cent
Construction	6 per cent
Repairs	3 per cent
Expense	15 per cent
Experimental	4 per cent
Engineering	7 per cent
	100 per cent

Those are the figures the manager's eyes will fall upon first. He knows what the normal percentages should be and he notes any change, instantly. Taking from a pigeon hole a similar slip for the preceding week, he compares the seven totals. Suddenly he calls for the "Labor Sheets," turns hastily to the expense section and scans it. Still unsatisfied, he demands the sheets for the preceding week and runs his finger down the expense subdivisions, comparing the two weeks. The finger stops at an item. The charge for helpers in some one department—(factory D, we will say) has increased from $120 to $130 since the preceding week. That means an extra man. But the total of production has not increased by any material percentage. A telephone call brings the foreman to the office and he explains why that additional helper has been necessary.

Summary of Labor Sheets

Week ending *Aug. 10/07*

Production		*97576*
Construction		*8941*
Repairs		*4516*
Expense		*22487*
Experimental		*6114*
Engineers		*10432*
	$	*150066*
Production	*65%*	
Construction	*6%*	
Repairs	*3%*	
Expense	*15%*	
Experimental	*4%*	
Engineering	*7%*	
	100	

The Eng. Magazine

FORM 5. SUMMARY OF LABOR DISTRIBUTION.

That is the marvel of the well-designed and correctly entered distribution of labor sheet—that it enables the manager of eleven-thousand hands to detect even so small a leak in expense as the engagement of one extra man. No foreman of a department, however large that department may be, can employ even an extra errand boy without its appearing as a distinct increase in the charge under that

heading, and it is little likely to escape the keen eye of any careful manager. No clerical force of any department can be increased by even a $6-a-week junior without that increase showing in the subdivided expense entries.

Of course such minute changes as these can be noted only in the expense columns, as the expense employees of a factory are usually a very stable factor. Production may fluctuate materially and the causes be perfectly natural. But it is the expense which managers watch, and need to watch, so closely. And it is here that the labor sheet is at once an indicator and a safety valve.

Its use in production is not far behind in value. In a great manufacturing plant, where foremen of large departments, with several hundreds of hands, are often more or less bothered in getting parts and supplies through in order to keep their crews thoroughly busy, it is not unusual that some classes of work are pushed ahead unduly while others get behind. But the manager studying the labor sheets can detect this tendency, at once, by noting the abnormally large amount paid out for wages on any one class of apparatus, and can at once take steps to avoid a possible congestion at one point and a shortage at others.

These labor sheets are also the means by which the cost department obtains the labor cost on any special machine, and also checks the estimates on standard apparatus. In obtaining the cost, say of a special size of Type C motor, order No. 133,262—all that is necessary is to examine the labor sheets under Type C heading, from the date of the issue of the order until its completion. The time occupied may be one week, or ten, but the addition of all charges against that order number gives, to a cent, the amount the company has paid in wages on that machine. And it is quickly done because the headings on the sheets are in a regular, fixed order which is never changed, and can be found as readily as a numbered page of a book.

The distribution of labor sheet easily becomes, in the hands of the manager, the greatest help he possesses in the control of his factory operations. It is, to his keen and observant eye, what the pulse of the patient is to the delicate and experienced perception of the physician. The most trifling changes in the conditions of output and expense may be easily noted by one who understands and studies the summary and its component sheets.

The warning of disproportion in production, or an insiduous increase of expense, comes quickly. The change, or trouble, which happens this week is shown up in unerring, indisputable, and locating figures next week.

A COMPRESSED-AIR LOCOMOTIVE FOR MINE HAULAGE.

Gauge 2 ft. 6 in.; weight 12,600 lb., all on the drivers. Cylinders 7 by 14 in.; storage pressure 700 lb., working pressure 125 lb. Built by the American Locomotive Co.

ECONOMICAL MATERIAL-HANDLING EQUIPMENTS FOR INDUSTRIAL PLANTS.

By Werner Boecklin.

"On the other side, true dispatch is a rich thing. For time is the measure of business, as money is of wares; and business is bought at a dear hand where there is small dispatch."—*Francis Bacon.*

THE question how to handle materials in industrial plants is one continually presenting itself to owners and engineers for proper solution. It is a problem entering into nearly all lines of business, in some assuming an important place in the general economy. As the demands upon the manufacturing plant have increased and a keener competition has necessitated radical changes, methods to meet the new conditions have been devised. Mechanical handling machinery has kept pace with the general mechanical development of the past decade and is now recognized as a distinct branch of manufacturing.

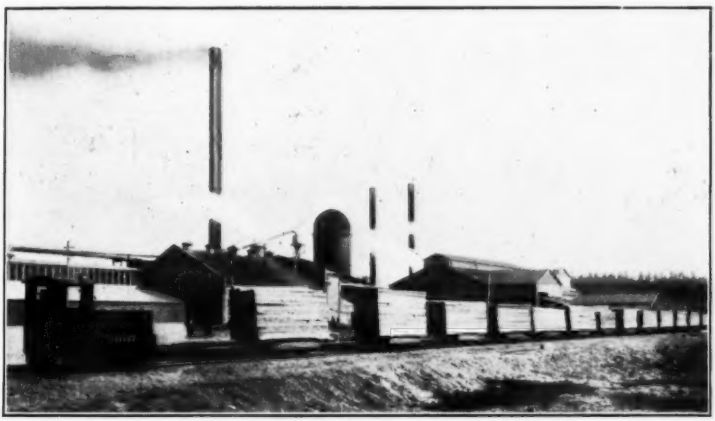
The ever-present question of cost, which the manager has daily to consider, is the germ from which have sprung the various systems designed to help the manufacturer to cut his operating expenses and to enable him to place his product, whether it be power, light, machinery, or one of a thousand different articles, upon the market at a lower price than was possible before the introduction of labor-saving devices. The engineer or owner is interested in securing that equipment which, being best adapted for his needs, will first materially

ELECTRIC LOCOMOTIVES FOR INDUSTRIAL HAULAGE.

Above, 9,500-lb. locomotive for Carpenter Steel Co. Two motors, 250-volts; gauge 2 ft. Below, 10,000-lb. locomotive for the Commissioners of Water Works, Cincinnati; two motors, 80 volts, gauge 1 ft. 9½ in. The Westinghouse Electric & Manufacturing Co.

reduce certain costs entering into the total cost of product; and second, will be safe and easy to operate. Cases often arise where any one of many different systems may be installed for doing the work. They are probably not all equally well adapted for the situation, and it is of vital importance, especially in large installations, that the condi-

tions be carefully studied with the view to securing the most economical equipment. In considering an investment it should be borne in mind that the unit cost for handling material with a given equipment is not a true measure of the efficiency of that equipment unless it is worked to its full capacity the year round, and such a condition prevails only in a limited degree. Such unit costs, too, may have little or no significance in certain cases, the effectiveness of the equipment being measured rather by its general all-round usefulness, which it is impossible to render into dollars and cents.



STORAGE-BATTERY LOCOMOTIVE HAULING GREEN LUMBER, POTLATCH LUMBER COMPANY.

Seven-ton locomotive built by the Jeffrey Manufacturing Co.

The conditions which are presented vary to such an extent that each case must of necessity be taken up as an independent problem. The facts for any specific case under consideration may be marshaled in some such form as follows:—

1.—Material to be handled.

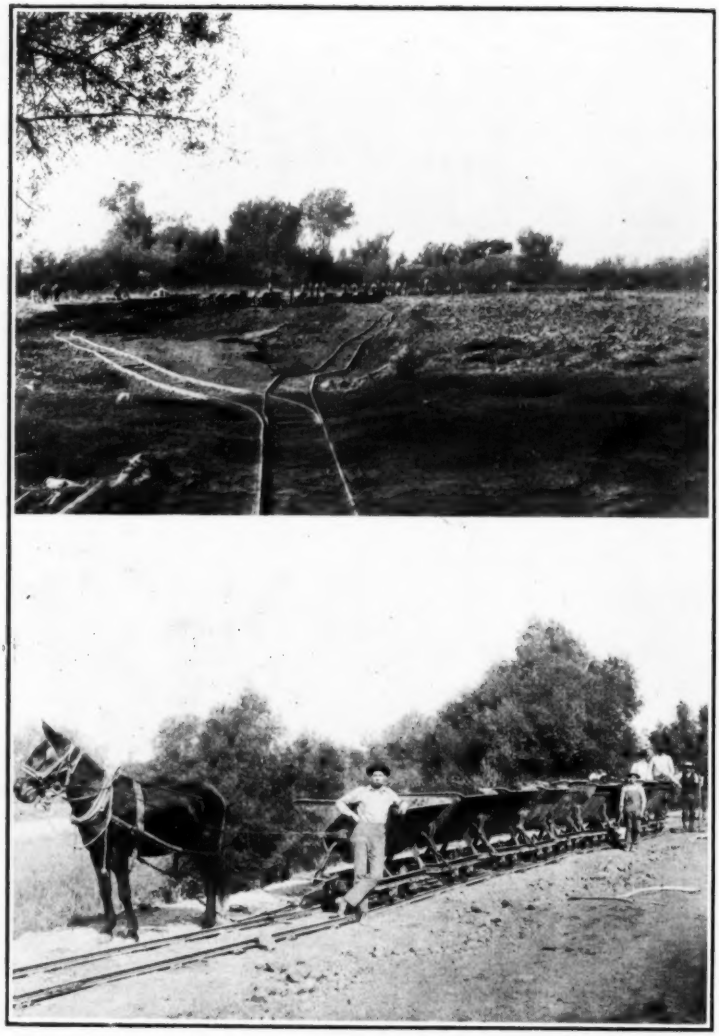
2.—Its nature or condition; whether heavy or light, in small or large pieces, wet or dry, hot or cold, sticky, having active chemical properties, in packages or in bulk.

3.—The amount in number or weight to be moved per hour.

4.—Whether material is to be moved horizontally or vertically only, or both.

5.—The power available.

6.—General information as to local conditions which will affect the installation.



KOPPEL INDUSTRIAL RAILWAY TRACKS AND CARS ON A BIG IRRIGATION JOB IN THE WESTERN STATES.

Showing the heavy loads which can be hauled by one mule; this train is made up of nine cars, each holding 36 cu. ft. The ease with which the track can be shifted is also apparent. The Arthur Koppel Co.

There are two general methods of handling materials; viz, the intermittent and the continuous. In the first instance the material is transported at intervals in a condensed form, as exemplified in a crane carrying a bundle of steel or a box of castings. In the second instance the material is transported in a more or less continuous stream, as for example a conveyor taking a supply of coal from an overhead storage pile. These two methods may for the purpose of this article be subdivided as follows:—

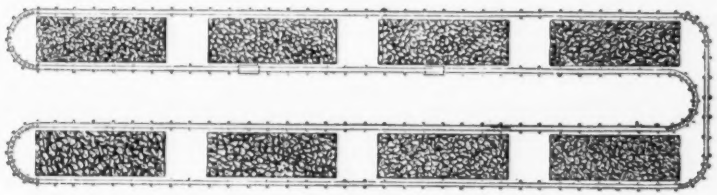
INTERMITTENT HANDLING.

1.—Industrial Railways
2.—Automatic "
3.—Cable "
4.—Traveling Hoists
5.—Aerial Cableways
6.—Cranes and Derricks
7.—Elevators or Hoists

CONTINUOUS HANDLING.

8.—Bucket Elevators or Conveyors
9.—Flight Conveyors
10.—Spiral or Screw Conveyors
11.—Trough or Pan Conveyors
12.—Belt Conveyors
13.—Reciprocating Conveyors

Of these general types there are various combinations and modifications.

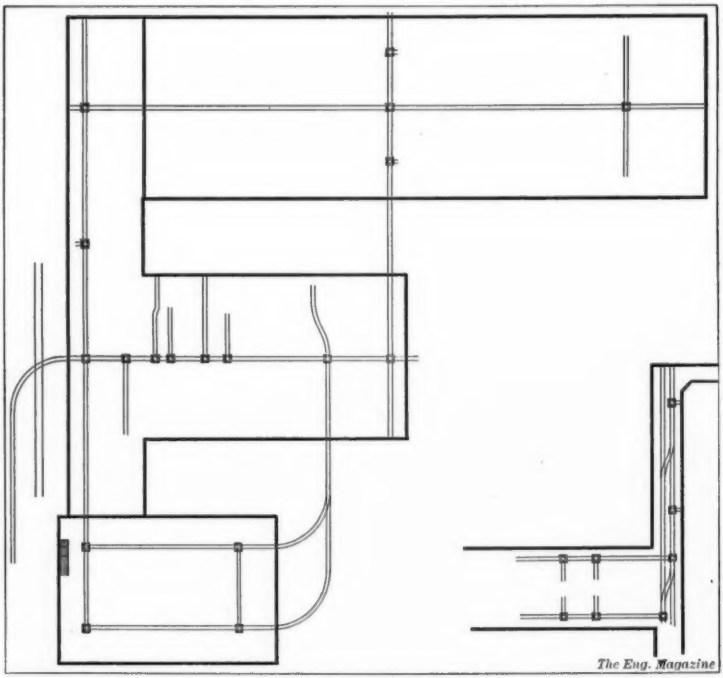


ARRANGEMENT OF INDUSTRIAL RAILWAY TRACKS, ROANE IRON WORKS.
The ore is dumped into the ore bins from standard-gauge railway cars. It is spouted thence into the industrial cable-railway cars and from these dumped to the furnace hoists; 1,000 cable cars are handled every 24 hours. Length of track 1,806 ft.
Installed by the C. W. Hunt Co.

INTERMITTENT HANDLING MACHINES.

Industrial Railways are generally understood to mean systems having gauges of 20 to 36 inches and cars having capacities from 1 to 10 tons. The track may be built in sections, the rails being securely attached to the steel cross ties by means of clips or rivets and

shipped in this form ready for placing. Curves, frogs, switches, crossings and turntables are made standard and usually kept in stock ready for shipment. Cars are made in many forms and sizes suitable for various conditions. The trucks are frequently fitted with roller bearings, thereby reducing the axle friction from one-fifth to one-third. For inter-shop transportation the industrial railway is often indispensable and the charges for maintenance are insignificant.



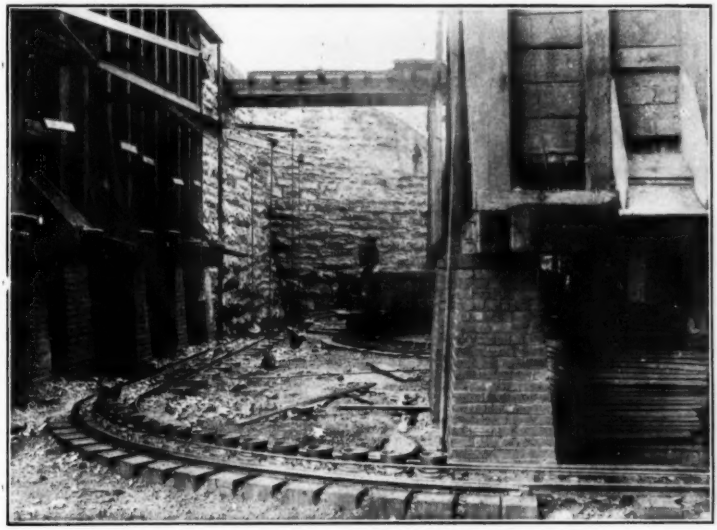
KOPPEL INDUSTRIAL RAILWAY SYSTEM, INSTALLED AT THE WAGNER ELECTRIC PLANT.
Scale 1 in. equals 72½ ft. Gauge of track 23⅝ in.

Such a system can be operated either by hand or by using some form of power. The kind of power to be employed will naturally be an important consideration. The two agents generally recognized as best adapted for factory and yard systems are the storage-battery locomotive and the trolley locomotive.

The advantages to be secured in the use of the storage battery are convenience, safety, and economy. The machine is always ready, night and day; no high-grade labor is required to operate it; it may

be run into any part of the works where either permanent or temporary tracks can be laid. Compared with steam or trolley, its safety is easily recognized as there are no sparks or overhead wires to contend with. The claim of economy, although not so easily proven, is borne out by an investigation of a number of installations now in operation. Considering the matter of economy it may be well to bear the following points in mind: the power is used only when the locomotive is in service; only enough power is taken to do the work required; the locomotive may be recharged at intervals during the day when it is not in use; with such a locomotive the material in an ordinary factory may be easily handled by one man.

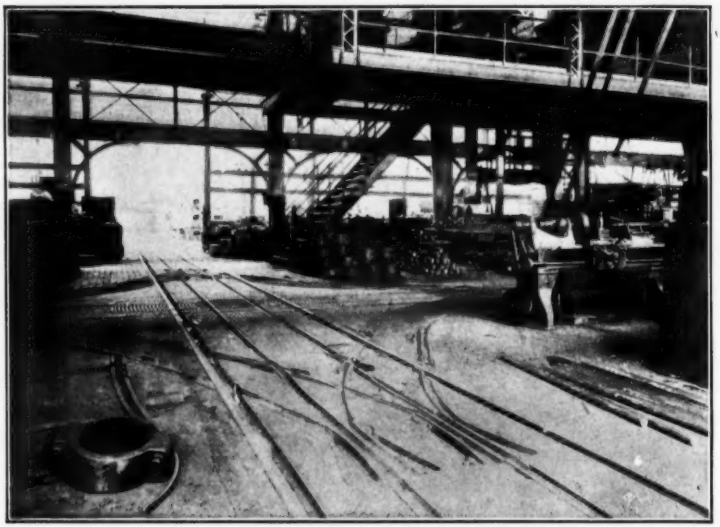
Aside from the question of available room for tracks, curves, switches, etc., an important factor in selecting a locomotive will be the maximum grade to overcome. Storage-battery locomotives may be used economically on grades below 5 per cent. For higher grades they are not suitable, nor are they fitted for long hauls, or speeds exceeding about 350 feet per minute.



THE CABLE ROAD AND ORE BINS, ROANE IRON WORKS.
The C. W. Hunt Co.

The other form of electric traction, the trolley locomotive, is applicable to longer hauls, steeper grades, and heavier loads than the storage locomotive. As with the latter type, no skilled labor is required for operation and it consumes no energy when idle. For fac-

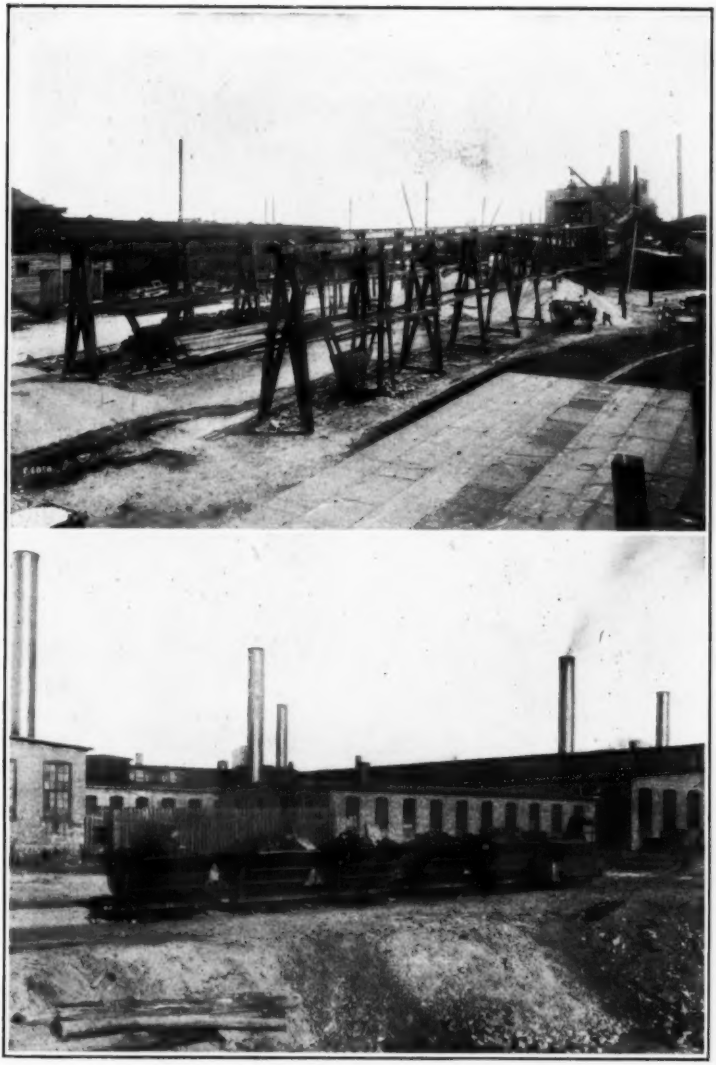
tory purposes, however, the trolley locomotive is not suitable on account of the overhead wire being in the way. In yards this objection may not be a serious one. By the introduction of the electromagnetic system the difficulty with trolley wires or third rails may be overcome, and one company at least is building industrial locomotives on this system. All contact buttons through which the current is supplied excepting those under the locomotive are "dead." Grades may run up to 10 or 15 per cent, but the average working grades for economy should not exceed 3 per cent for long hauls or 5 per cent for short ones.



INDUSTRIAL RAILWAY TRACKS, THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.
Installed by the C. W. Hunt Co.

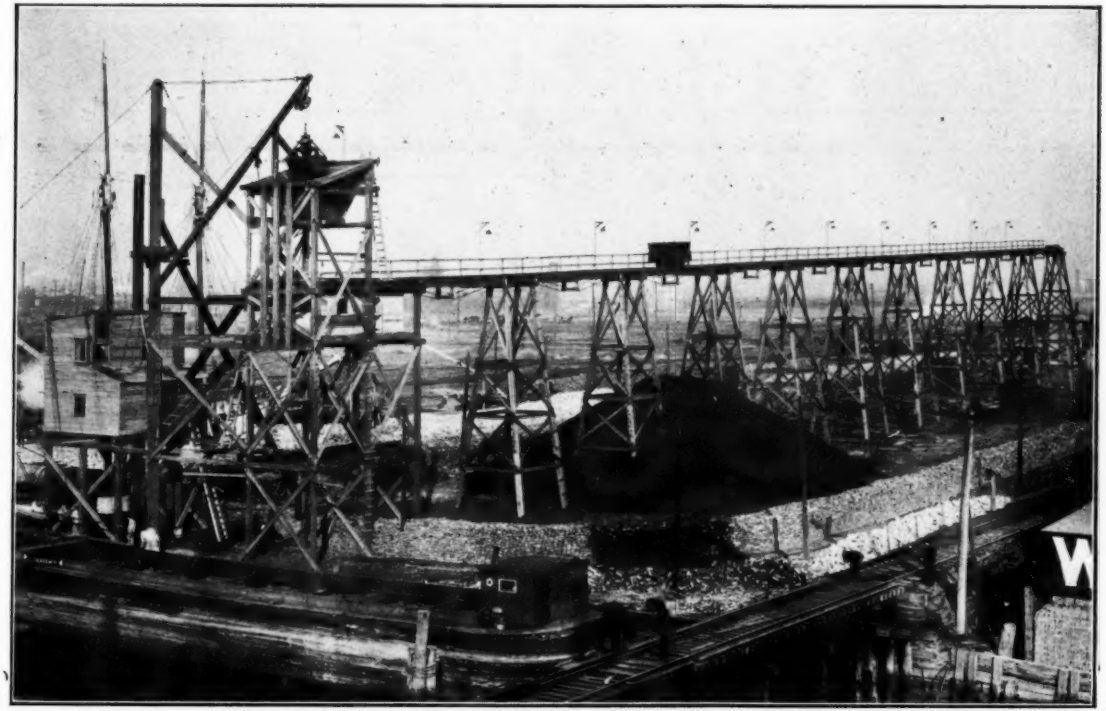
The average cost for hauling coal by this method in the case of seven different installations, taking into account labor, depreciation, and supplies, interest not being figured, was less than 3 cents per ton. The amount hauled ranged from 300 to 900 tons per day.

The Automatic Railway is one of the oldest methods in use for eliminating labor from the problem of handling materials. The essential parts are the track, having a gauge of about 22 inches, properly supported on trestle, an automatic dumping car, and the "triangle," or counterweight, used as a storage of energy, with cable and necessary sheaves. The system is extensively used for handling



INSTALLATIONS FOR THE HANDLING OF COAL AND STONE.

Above, is an automatic road for conveying sand and stone at the yards of the N. Ryan Co., N. Y.; it shows the "triangles" or counterweights. Below is a 5-ton storage-battery locomotive hauling coal on a 3 per-cent grade, Bridgeport Malleable Iron Co. plant. Both installations made by the Mead-Morrison Manufacturing Co.



SHUTTLE CABLE ROAD FOR COAL HANDLING, NEWTOWN DOCK, BROOKLYN RAPID TRANSIT RAILROAD.
The road is 350 ft. long, and uses one 3-ton car; capacity 600-800 tons per day. Installed by Mead-Morrison Mfg. Co.

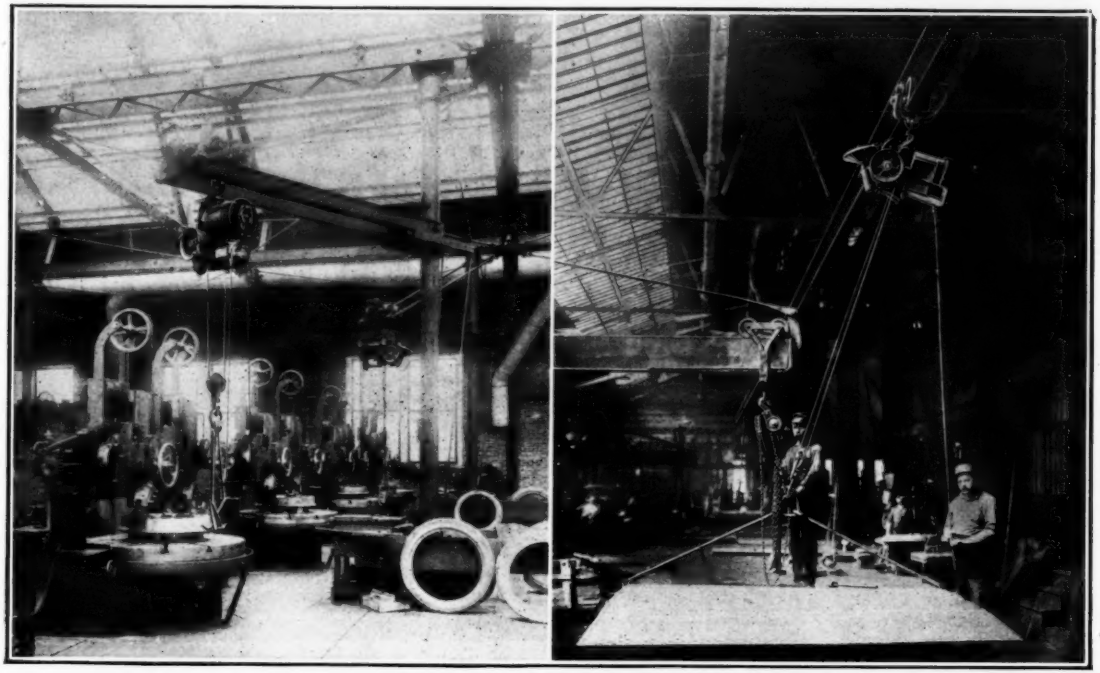
coal, or other material in bulk, along the water fronts for delivering to storage piles.

To operate successfully the track should have a grade of about 3 per cent and the length should not exceed 400 feet. The car acquires sufficient momentum to elevate the counterweight which by its fall returns the empty car to the loading point. It is made to discharge its load at any point by means of a suitable tripping device.

INDUSTRIAL-RAILWAY INSTALLATION IN THE KOPPEL PLANT.
Cars are loaded by traveling crane, and carry the material from machine to machine until the work on the individual piece is completed. Then they take it to the assembling shop. The car does not have to turn back, nor does it encounter another in its travel. All the buildings are connected by this narrow-gauge track.
The Arthur Koppel Co.

The cost of such an installation is comparatively low, and cost of operation is reduced to a minimum. An automatic road 250 feet long, with an average run of 100 feet, and operating a 1-ton car, will handle 60 to 70 tons of coal per hour. Such roads are installed in many cases with mast and gaff rig and electric or steam hoists for handling tubs where the tonnage is too light to warrant larger plants. In one case where 20,000 to 30,000 tons of coal are handled yearly, using tubs and an electric mast and gaff equipment, it costs, including labor and all fixed charges, about 7 cents per ton. This figure would be cut to less than half in the case of large plants. The current in this case must be purchased, which, at the high local rate, adds materially to the cost.

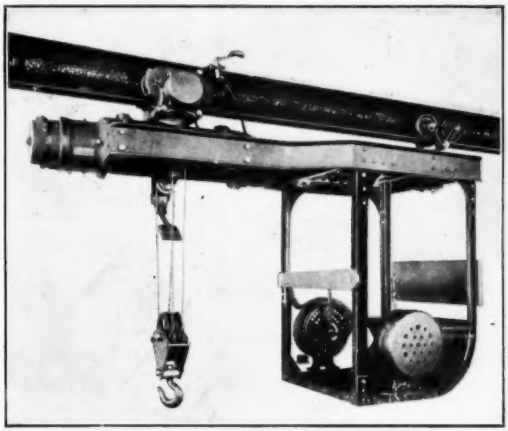
A Cable Railway consists of the driver, endless steel cable with



APPLICATIONS OF THE PORTABLE ELECTRIC HOIST IN SHOP WORK.

On the left, a jib crane with 2-ton portable hoist serving boring mills and controlled from the floor. Each hoist serves from two to four mills. On the right, monorail equipped with 2-ton hoist for handling boiler plate. It is brought from stores on the trolley, transferred to chain blocks on the jib crane, swung to the punches, and returned the same way. The single-hook suspension enables the hoist to work at an angle as great as 45 degrees. Built by the Yale & Towne Co.

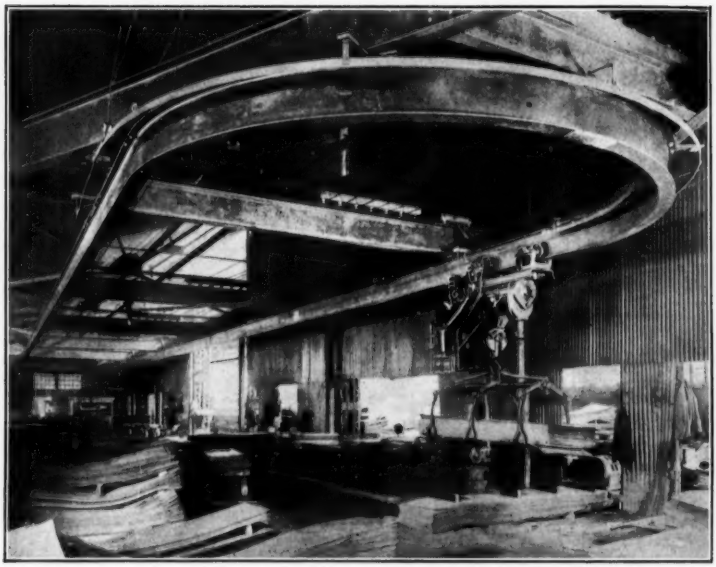
guide, curve, and supporting sheaves and take-up, one or more cars with cable grips, and necessary track. Two systems of railways of this class are in use, the shuttle, or reversible, and the continuous. The first is used for small capacities, (40 tons an hour and under,) the second for capacities of 60 tons and over. Two cars are usually employed on the shuttle system and two tracks. While one car is being carried loaded to the end of the line, the other one is returning empty to the loading point. The cable driver must therefore be a reversing machine. On a continuous cable road the cable runs in one direction, the cars being gripped to it at intervals. The speed of cable will vary from 200 to 500 feet per minute, and the cars carry from 2 to 5 tons of material. Cars may be spaced a minimum distance apart of 50 feet. Grades of 7 to 10 per cent may be used without difficulty.



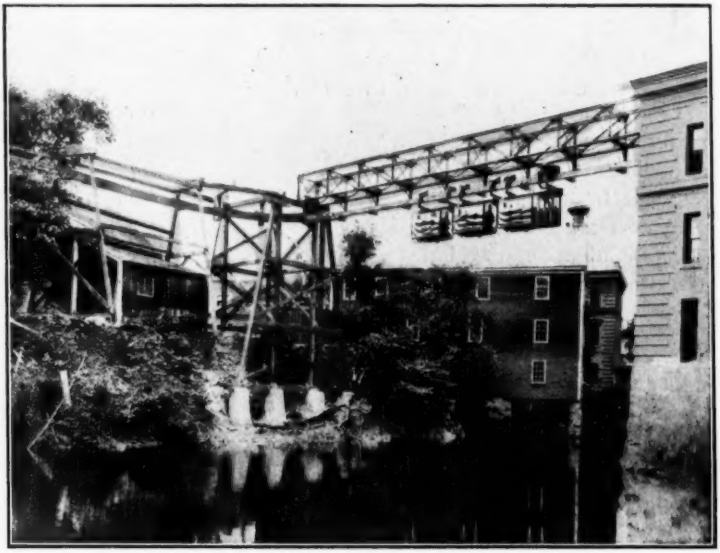
A MONORAIL ELECTRIC HOIST, WITH CAGE.
Manufactured by the General Electric Tool Co.

Aside from minor repairs and renewals the chief items of operating cost are labor, power, and renewal of cable. A cable with ordinary attention may last from 9 months to a year, and, with special care, much longer than this.

A Traveling Hoist is one of the commonest and most economical methods for handling material in the factory. Such a system consists in its simplest form of a properly supported beam, or track, carrying a trolley carriage from which is suspended a sling for handling loads, or preferably, a chain block attached to the trolley for hoisting the load. An electric or pneumatic hoist may be used with suitable trolley carriage, and, by adding a small motor to the trolley carriage in case of the electric hoist, both movements may be accomplished by power. By the further addition of a second trolley carriage and a suitable frame and cage for the operator, a very effective machine may be produced, and one which can be employed in an endless number of

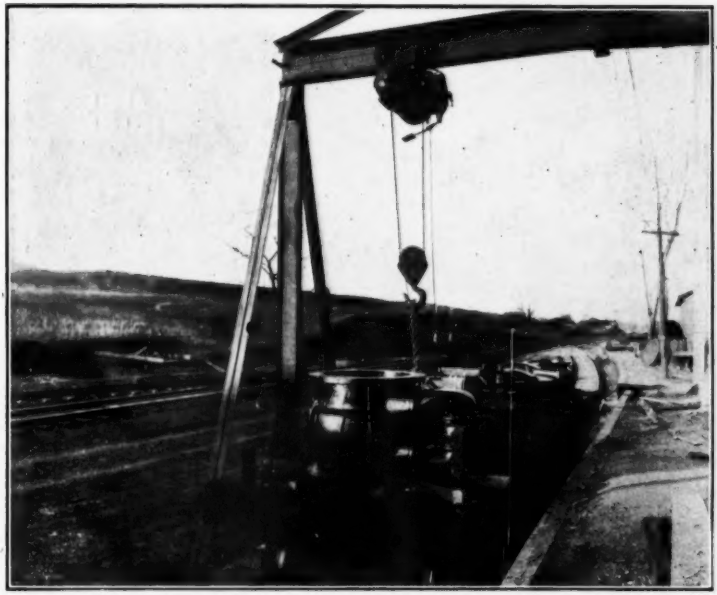


ELECTRIC MONORAIL TRAVELING HOIST WITH CAGE, FOR HANDLING SHEET STEEL.
Manufactured by the Sprague Electric Co.



TELPHER TRAIN WITH THREE TRUCKS, WORKS OF THE WALTER BAKER CHOCOLATE COMPANY.
Each truck carries 2,000 lb. of cocoa in bags. Installed by the Dodge Coal Storage Co.

situations. Such a system may be laid out with suitable switches and curves to cover a large portion of a given floor space, or it may be used to transport over long distances and difficult ground. Hoisting speeds vary from 20 to 50 feet per minute, and trolley speeds range from 50 to 250 feet per minute. By means of transfer beams a machine of this type may be used for carrying loads from one part of the shop to another, crossing from bay to bay. As stated, compressed air hoists are used in connection with a monorail system, but they are not so flexible as electric hoists although highly practicable under special conditions.

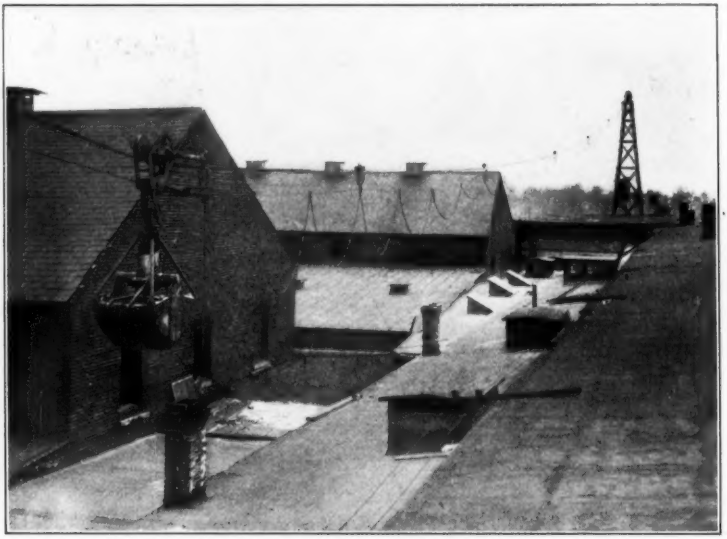


SHEPARD ELECTRIC HOIST UNLOADING CARS, RENSSELAER MANUFACTURING COMPANY.
Hoist is of 10-tons capacity. Installed by General Pneumatic Tool Co.

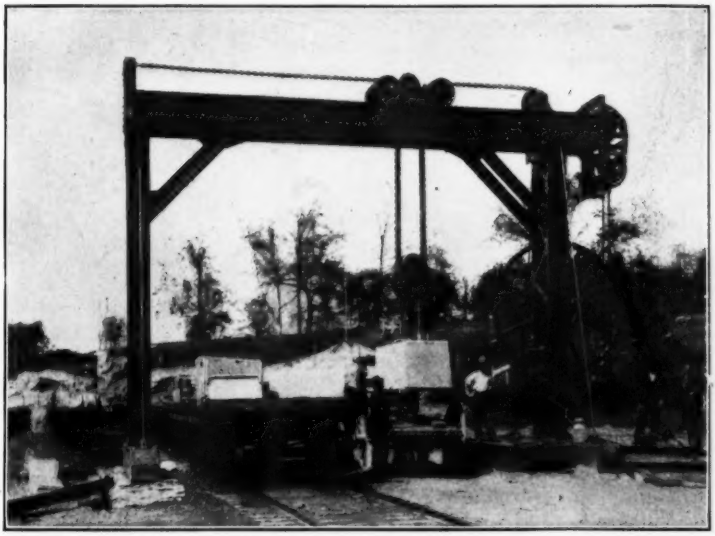
The cost of handling material by means of such a system is always difficult and in most cases impossible to determine. We know that, taking into account the various shiftings and hoistings of materials throughout a plant, a vast amount of time and much money can be saved by such an overhead method, and that the installation in some cases will pay for itself many times over in a year.

Aerial Cableways consist of a main cable on which the trolley carrying the load runs, stretched between elevated towers, a traversing

cable for moving the trolley, and a hoisting cable for the vertical movement of the load. In some cases a third cable is used for dumping the load. The operating cables are controlled by one man at one end of the line. Cableways are practicable up to a length of 2,500 feet. When the length exceeds about 250 feet, fall-rope carriers are employed. These are small hangers running on the main cable and spaced at regular intervals to prevent the hoisting rope from sagging. If not used the weight of the rope will be sufficient to lift the bucket or hook off the ground and prevent loading. Equipments of this class are used extensively by contractors and also find a limited application in industrial plants. They are specially applicable for transporting material over difficult ground, or where existing structures or other obstacles preclude the use of any other system. Steam or electric power is commonly used for operating. In the case of a steam equipment either a separate boiler is installed, or, as is often possible in an industrial plant, steam is drawn from the main power station. In this latter case and with the use of an electric hoist, power is used only when needed. A skilled operator is absolutely necessary. To operate a steam equipment of this kind will cost, including the wages of engineer, fuel, and supplies, from 5 to 7 dollars a day.



DOUBLE-DRUM ELECTRIC AERIAL CABLEWAY HANDLING SAND.
Length 700 ft.; capacity of bucket 1¼ yds.; a trip every 3 minutes. Installed for the Pittsburg Plate Glass Co. by the Mead-Morrison Manufacturing Co.

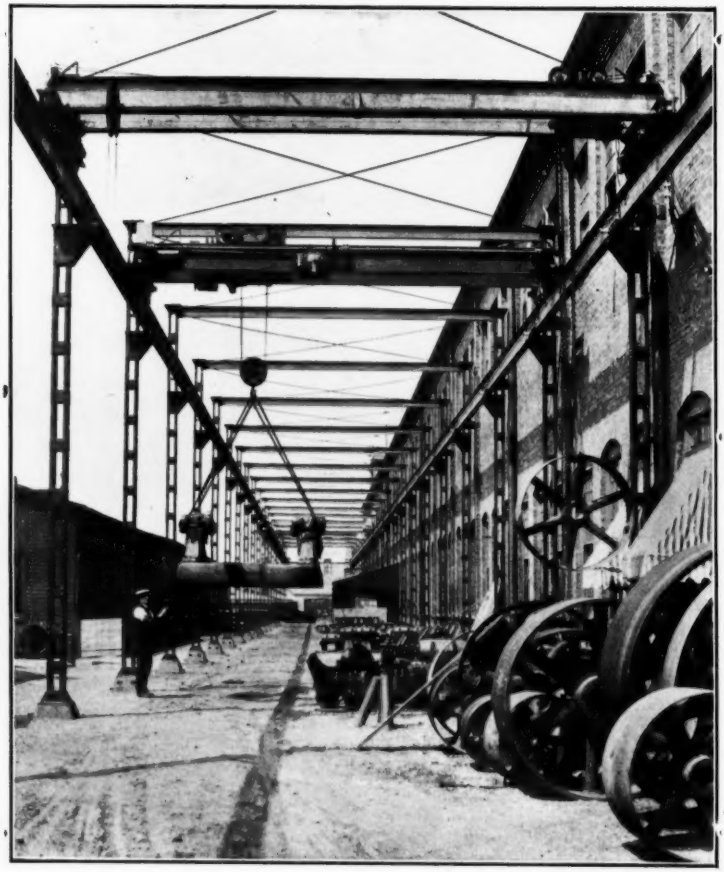


STATIONARY HAND BRIDGE CRANE, NEW YORK, NEW HAVEN & HARTFORD RAILROAD.
It is of 30-tons capacity. Built by the Brown Hoisting Machinery Co.

Cranes may be conveniently sub-divided as follows:—

1.—Overhead Traveling Cranes.
2.—Gantry Cranes.
3.—Cantilever Cranes.
4.—Stationary Bridge Cranes.
5.—Pillar Cranes.
6.—Jib Cranes.
7.—Locomotive Cranes.
8.—Derricks.

One or more overhead traveling cranes will be found in any large machine shop or foundry of the present day. Depending upon the importance of the location and the character of the service, these cranes are operated either by hand or by power, usually electric. In its application to the shop or yard one of the chief advantages of this type is that the full ground area between rails or runways can be covered by the hook of the hoist. For quick action, long travels, and heavy loads, the power crane is preferred to the hand-operated machine. The main hoist, supported on a suitable trolley carriage which travels from end to end of the bridge, has a hoisting speed under full load between 10 and 25 feet per minute. The trolley

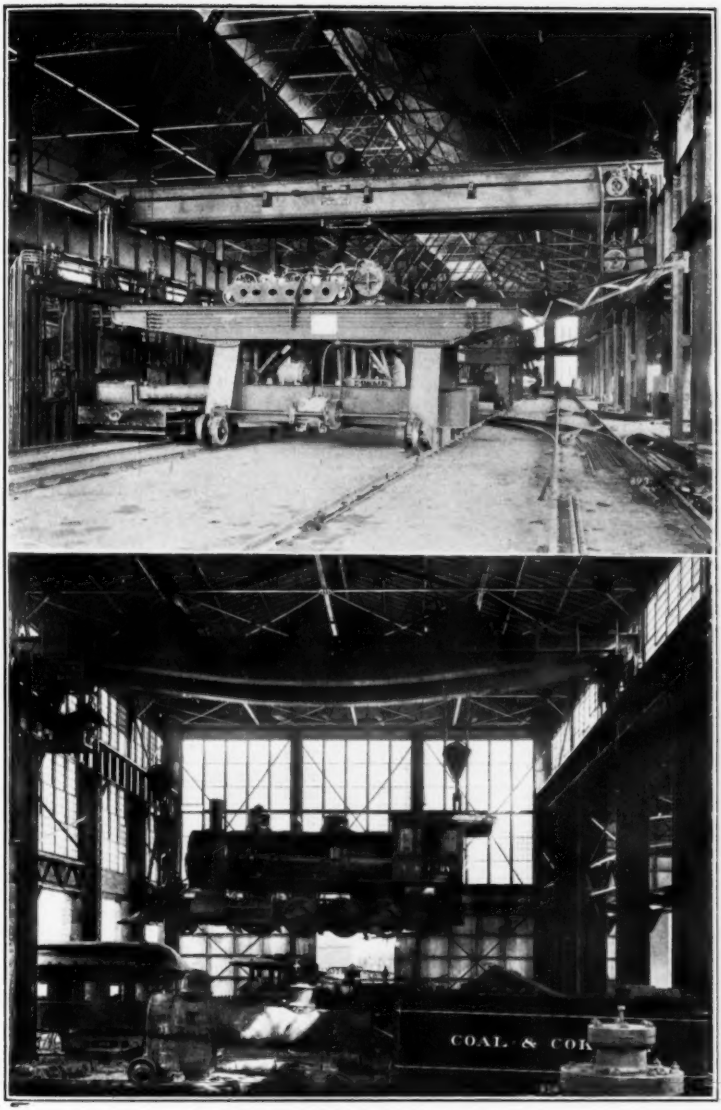


UNLOADING YARD CRANE, SHOPS OF THE GENERAL ELECTRIC COMPANY.

Built by the Sprague Electric Co.

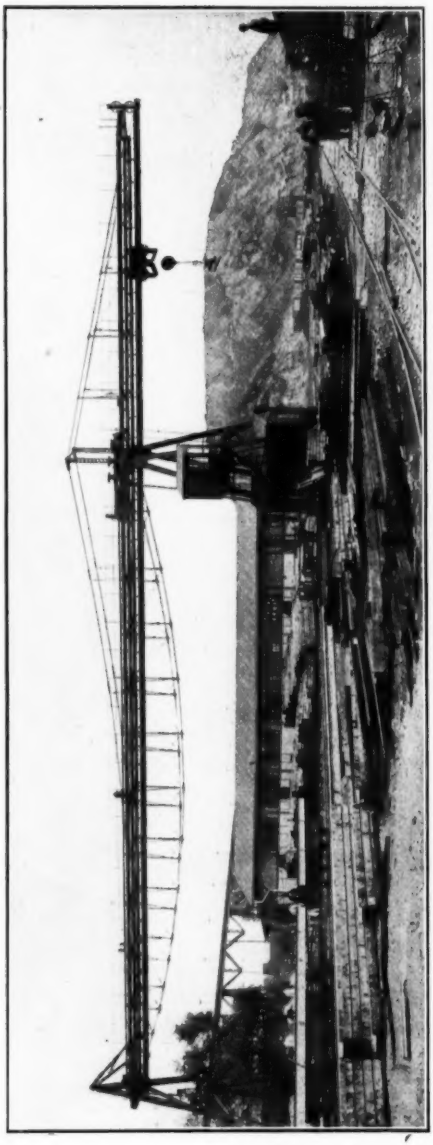
travels at about 100 feet per minute under full load, and the bridge at about 250 feet per minute. Much higher speeds for bridge travel have been advocated, but there is a chance for an undue amount of swinging of the load at very high speeds.

The nature of the work may be such that an auxiliary hoist for light loads and high speeds may be advantageously installed. The saving in operating expense in a case where, with a 50-ton crane for example, 75 per cent of the hoisting can be handled by an auxiliary,



EXAMPLES OF HEAVY CRANES IN SERVICE.

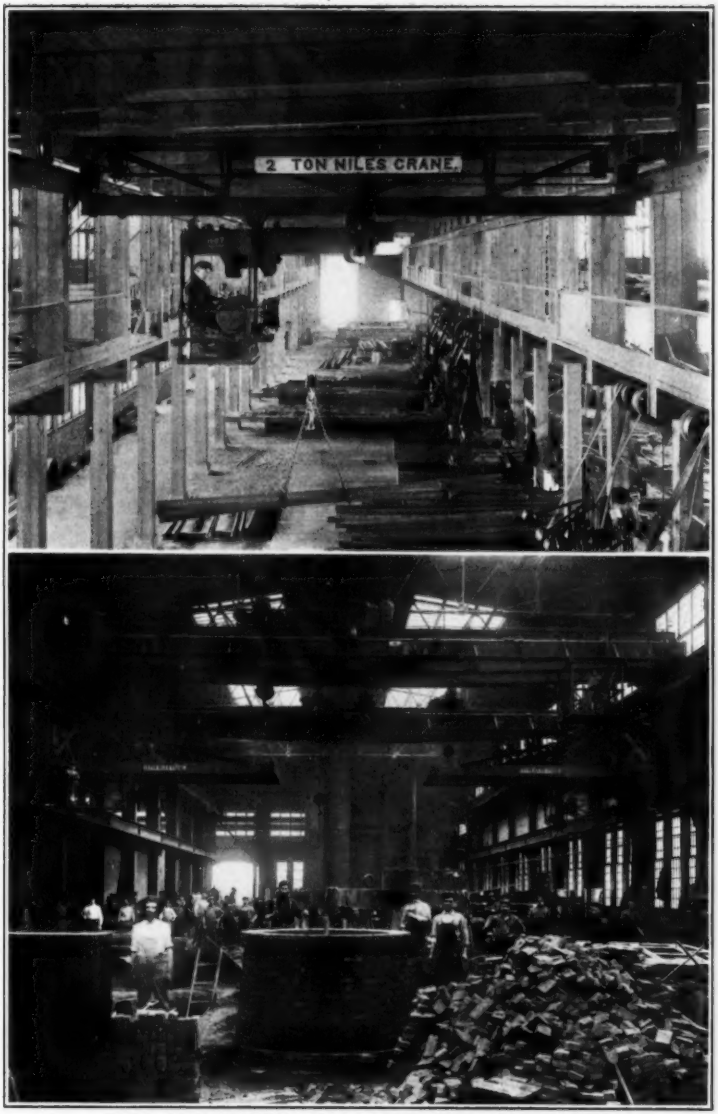
Above, 40-ton crane and two Morgan electric floor-type open-hearth charging machines, open-hearth department of the Lackawanna Steel Co. Below, a 120-ton double-trolley crane, each trolley of 60-tons capacity with 5-ton auxiliary hoist; span 65 ft.; operated by seven electric motors. Coal & Coke Railway Co., Elkins, W. Va. All built by the Morgan Engineering Co.



GANTRY CRANE, WITKOWITZER BERGBAU UND EISENHUTTEN GEWERKSCHAFT, MORAVIA, AUSTRIA.
Of 4-tons capacity. Built by the Brown Hoisting Machinery Co.

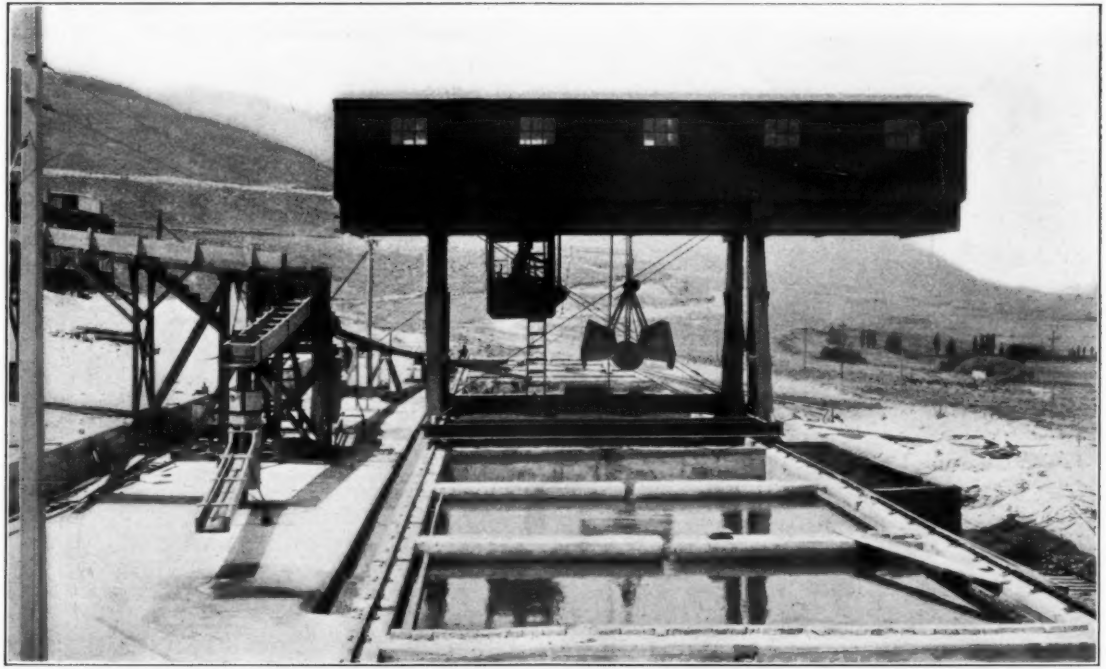
will be at once apparent. When the time and money saved by the installation of an overhead-crane system are considered, the charge against operation becomes a negligible quantity.

Gantry Cranes consist essentially of a bridge supported at either end upon movable piers. There are cases where one pier is eliminated and one end of the bridge runs on an elevated track. In some machines of this class the piers are rigidly attached to the bridge, with the frequent result that the irregularities in the track produce a severe racking throughout the structure. In other designs the bridge is not rigidly connected to the piers, but is pivoted at one end, and suspended from a shear at the other. If one end runs ahead of the other, or if the track is out of level or alignment, the crane still operates without



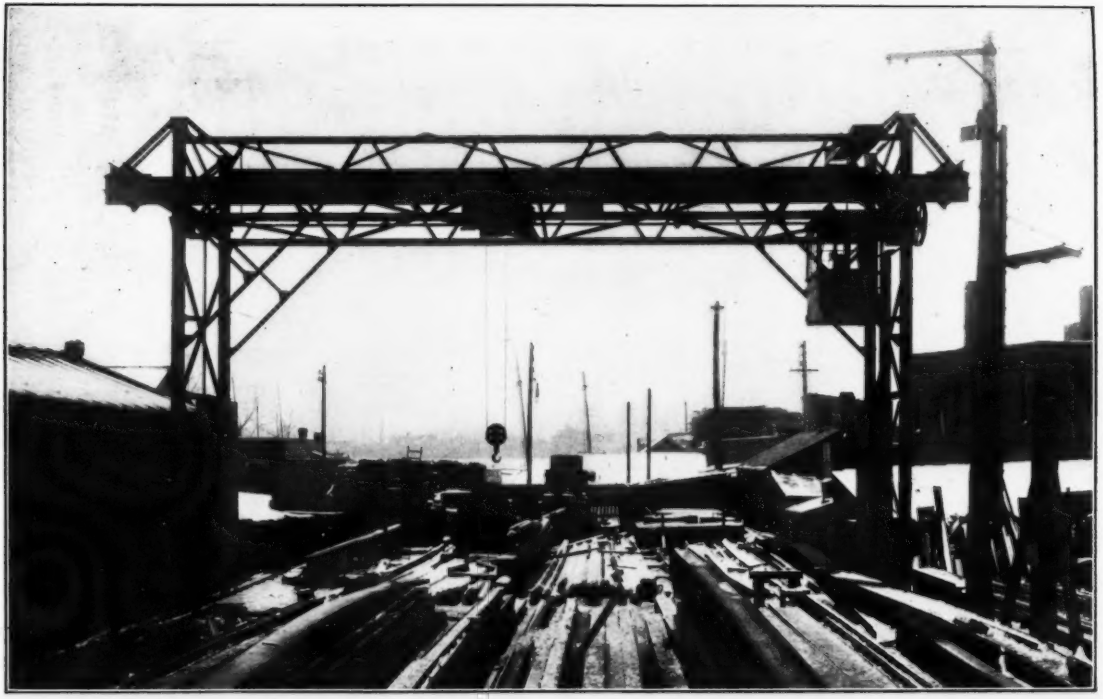
CRANE INSTALLATIONS IN MACHINE SHOP AND FOUNDRY.

Above is a 2-ton transfer crane. Below, a pair of heavy electric traveling cranes, 60 and 40 tons, 75-ft. span, the former with 10-ton auxiliary hoist, supplemented by traveling wall cranes of 10-tons capacity, 25-ft. arms. Installed for the Reading Iron Co. by the Niles-Bement-Pond Co.



TRAVELING CANTILEVER DREDGE CRANE, WITH CLAM-SHELL BUCKET.

Installed at Garfield plant of the Utah Copper Co., for handling wet copper concentrates from settling basins to cars. Length of bridge over all, 41 ft. 6 in.; wheel base 19 ft. Capacity of trolley 3½ tons; hoisting speed 60 ft., trolley travel 150 ft., gantry travel 30 ft. per minute. Pawling & Harnischfeger.



SPECIAL ELECTRIC GANTRY CRANE FOR HANDLING STRUCTURAL MATERIAL.

It is of 3-tons capacity, 50-ft. span. A self-contained hoisting machine travels on the lower flange of a bridge girder which overhangs the supporting frame 10 ft. This enables the crane hook to reach a car or other point that far beyond the lot line, and also facilitates the swinging of steel angles and beams. The trolley can run off the crane onto a fixed I-beam track. Built by the Northern Engineering Works.

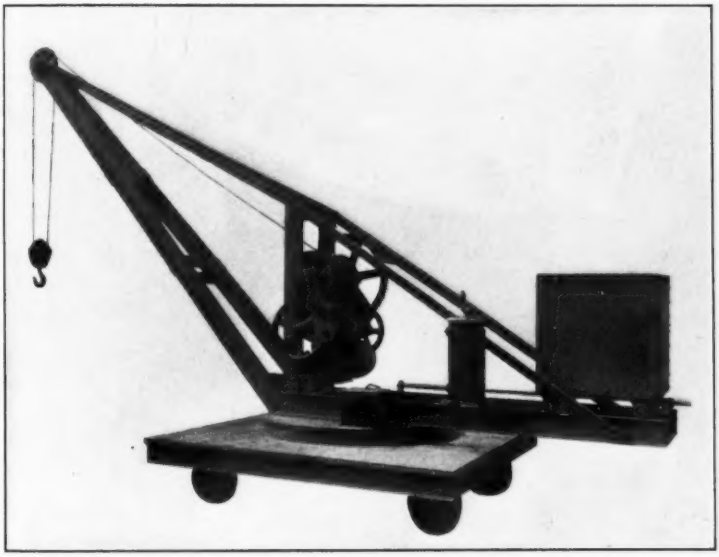
any undue strain being imposed upon any part. Such cranes are built with spans up to 300 feet, and capacities of 5 and 10 tons are common. The hoisting speed under full load ranges between 200 and 300 feet per minute, trolley speed 800 to 1,200 feet per minute, and bridge speed 300 to 600 feet per minute. Either steam or electric power may be employed for operating and the machinery may be conveniently housed on the double-track pier. There are three ways commonly used of applying the power to the bridge wheels:—power may be transmitted across the bridge through a universal-joint shaft, and thence to the wheels by gears and vertical shafting; the vertical shafting may be replaced by sprocket chain; or independent motors may be placed on the piers and the wheels driven as in case of street-car motors. The three motions are under the control of one operator. Gantries are extensively used in structural yards, areas for storage of materials such as coal and ores, shipbuilding yards, and similar localities, and are built with various modifications to suit requirements.

Cantilever Cranes may be classed as modified gantry, the bridge of the latter being extended in either direction and the piers brought closer together. Cranes of this type are built either to travel, to revolve, or to have the two motions combined. They have been constructed with spans exceeding 350 feet. The general principle of operation is the same as for gantries. A counterweight is employed which balances the load by automatically assuming a position on its arm corresponding to that held by the load on the opposite arm. All movements are at comparatively high speeds, and capacities of 10 or 15 tons are common. As generally built, the gauge of the runway track is about 20 feet. These machines are largely used in shipbuilding yards, coal-storage and rehandling plants, and steel-plant yards. The principal advantage in the use of such a crane lies in the fact that heavy loads can be handled with ease and dispatch over very large areas, without interfering in any way with other operations going on in the same area, and irrespective of any obstacle in that area.

Stationary Bridge Cranes are rather limited in application, being used principally for railroad stations and freight yards. Under these conditions they are seldom in commission, and are not as a general thing equipped with power. The crane consists of a main girder, or bridge, sufficiently long to span the required space, and rigidly supported at either end by suitable columns, or piers. In the case of hand machines the hoisting and trolleying mechanism is attached to the side of one of the piers at a convenient height. This crane is

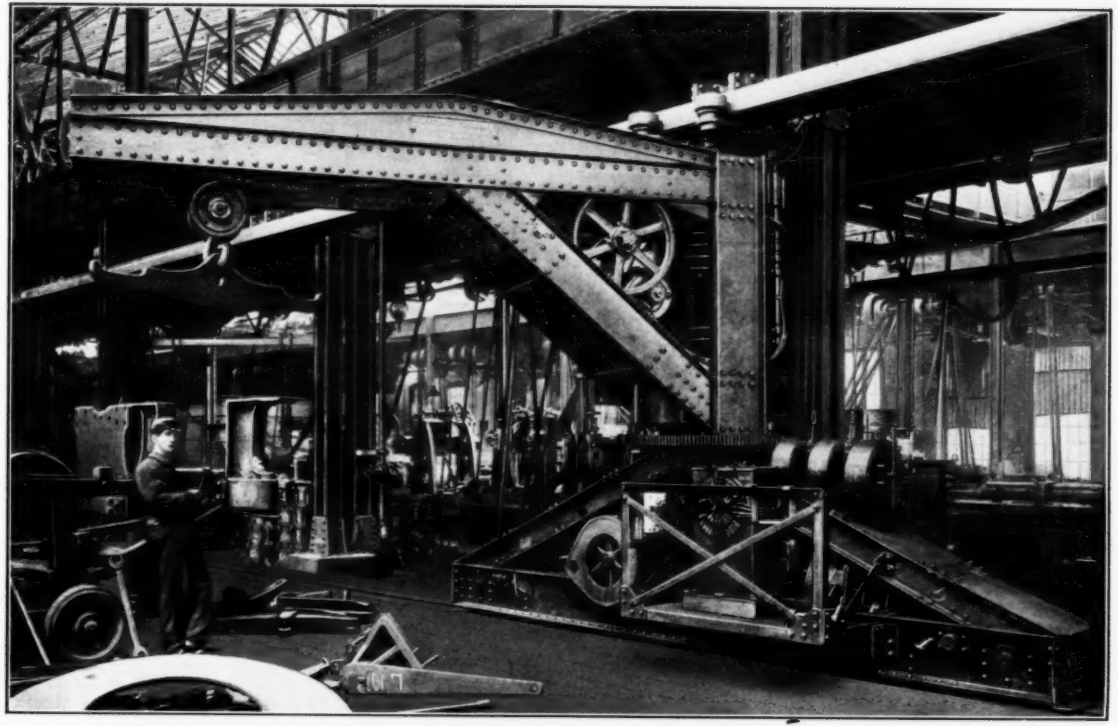
sometimes installed in industrial plants for loading and unloading cars, and is built in sizes from 1 to 2 tons to about 30-tons capacity.

Pillar Cranes have, in addition to the operating mechanism, three structural parts, namely; the pillar, which is usually made of cast iron; the inclined boom, made of structural shapes; and the ties, made of round rods, or eye bars, to support the outer end of the boom. Cranes of this type are installed where, on account of local conditions, the mast can not have a support for its upper end. This necessitates a mast of heavy construction to withstand the bending strains put upon it. Either hand or power equipment is employed, depending upon the importance of the crane. These cranes are built with lifting capacities from 1 to 30 tons, and with radii from 10 to 40 feet, and are suitable for use in freight yards, industrial plants, at docks, etc.



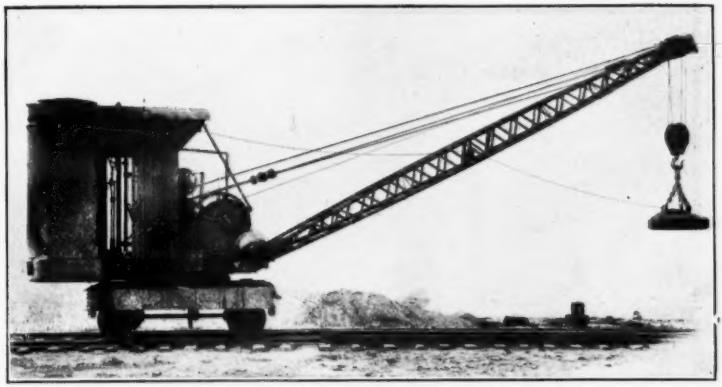
ELECTRIC TRUCK CRANE, FIXED RADIUS, 5-TONS CAPACITY.
Radius about 15 ft., hoist operated by alternating-current motor; truck propelled by hand. Northern Engineering Works.

Jib Cranes are a type belonging to the early history of cranes. Of the smaller machines for handling materials in the industrial plant, the jib crane in its various forms is probably more used than any other class. Its application is primarily local, with certain exceptions to be mentioned later, being limited in scope by its radius, which is small. The designs are various, but the essential parts are the hoisting mechanism, the mast, strut or tie, and boom. Upper and lower



JIB CRANE IN BURNSIDE SHOPS OF THE ILLINOIS CENTRAL RAILROAD.

Equipped with the Western Electric Company's crane motors.



LOCOMOTIVE CRANE AT THE INGERSOLL-RAND WORKS.
Of 10-tons capacity, with 52-in. Electric Controller & Supply lifting magnet. The Brown Hoisting Machinery Co.

bearings are provided for the mast to swing in. These cranes are built in sizes ranging from less than 1 ton capacity to 10 and 20 tons, with radii to 20 and 25 feet. In the smaller capacity cranes hand power is commonly used for all movements, although with the modern development of light electric hoists they are frequently equipped with plain trolleys carrying electric hoists. Local conditions determine the kind of power, which may be hand, pneumatic, hydraulic, steam, or electric. Electric equipment for this class of work is monopolizing the field, principally on account of the great flexibility of the agent. The jib crane when converted into a traveling wall or floor crane loses in part its local characteristic and assumes some of the functions of the overhead crane, and in fact the wall crane is generally used as auxiliary to the main shop crane. For handling plates and castings over tools, for general foundry and machine-shop service, and for similar work, jib cranes have become indispensable, and pay for themselves many times over during the year.

Locomotive Cranes are built in most instances to travel on standard-gauge tracks, in order that they may be utilized on the existing track system throughout the shops and yards where they are to be used. Cases arise, especially when greater stability is required, where broader gauges are employed. Three movements are generally sought; rotating, traveling, and hoisting, and these are accomplished through the medium of either steam or electric power. The operating machinery is mounted on a rotating bed, which revolves about

A LOCOMOTIVE CRANE TRANSFERRING COAL FROM CAR TO HOPPER.

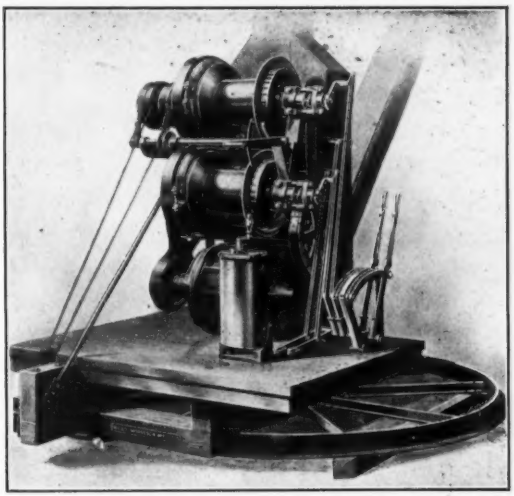
The crane shown hauled two loaded coal cars containing 40 tons each about ¼ mile and unloaded them in 1½ hours. The Browning Engineering Co.

a central pin, the whole being attached to the truck frame. Vertical engines are preferable to horizontal, causing less vibration of the machine, and two coupled at right angles insure prompt starting. To travel the crane along its track requires more power than the other operations, and all the wheels in a four-wheeled crane should have power applied to them, thus insuring the use of all available traction. This is important on curves and wet or bad tracks, as the overhanging load may relieve one pair of truck wheels of a portion or of the whole of the weight which would come upon them. Capacities run from about 2 to 20 tons and radii from about 10 to 40 feet. When handling coal such a crane can easily make 50 trips per hour, and, figuring on a basis of a 1-ton grab bucket, the crane can handle 500 tons if working continuously for 10 hours.

Machines of this class are seldom called upon to do continuous service. An actual case may be cited where a locomotive crane averaged 170 tons per day at a cost, exclusive of interest and depre-

ciation, of 2.14 cents per ton. Interest and depreciation will add about 1.75 cents per ton, giving a total of 3.89 cents per ton. The actual cost per ton is not so important as a comparison of costs between old and new methods of doing the work. In the case cited the reduction in cost per ton due to the use of the crane amounted to over 12 cents.

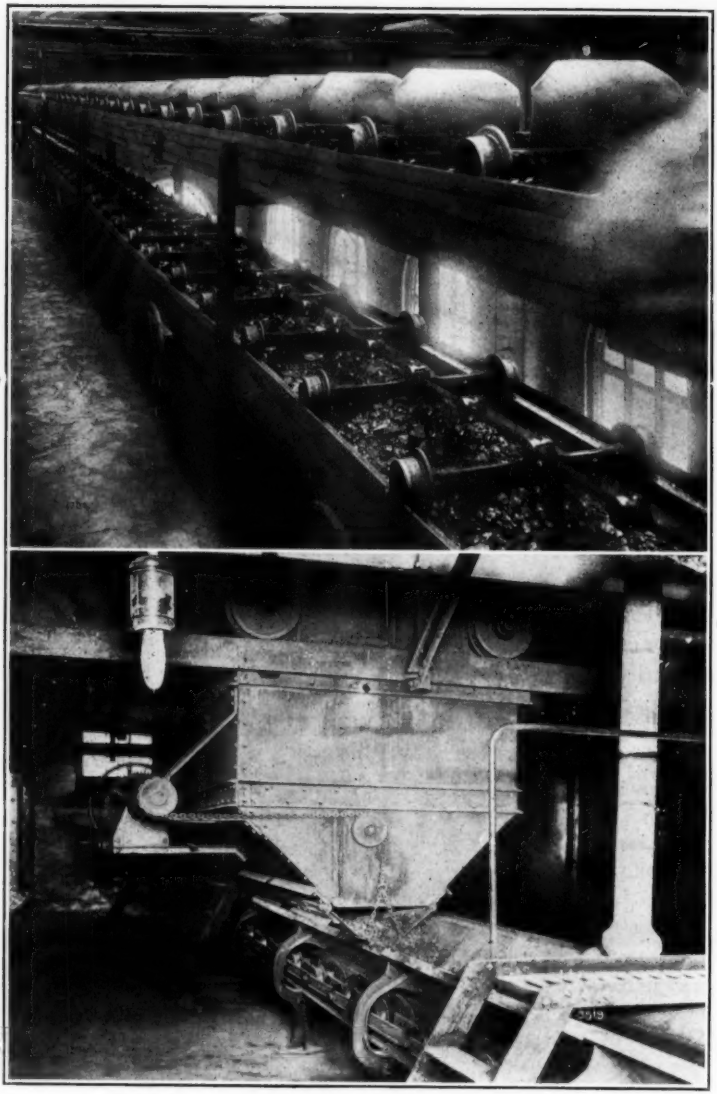
Derricks, as labor-saving devices, are probably more widely used than any other class of machines. A description is scarcely needed. There are however some recent developments which are worthy of mention. Manufacturers are equipping contractors' derricks with electric machinery making them self-contained. For swinging, two methods are in use: in the first, a bull wheel is attached to a frame under the derrick and is fixed, the derrick and platform being revolved by a steel rope actuated from a specially designed winch on the end of one of the drum shafts; in the second, a spur wheel replaces the bull wheel, and a vertical shaft to which a pinion is keyed meshing with the wheel has power transmitted through it from a horizontal shaft. Derricks of some such design may be used in industrial plants where the current is available at a low price and they offer in such a position certain advantages over the steam-actuated derrick.



HOIST FOR REVOLVING DERRICK.

Electrically operated. Revolved by rope and clutch, operating directly on the bull wheel, with no gears. The Mead-Morrison Manufacturing Co.

Skip Hoists are used for handling such materials as ores, coal, limestone, sand, or ashes. The essential parts of such a plant consist of the hoisting mechanism, operated by steam or electricity; the cable and necessary sheaves; the skip, or bucket; and guides, or



COAL AND ASH-HANDLING INSTALLATIONS FOR LARGE BOILER-HOUSE WORK.

Above, a motor-driven monobar flight conveyor, 90 tons an hour capacity, boiler house of the Allegheny City Water Works; below, ash hoppers feeding a Peck overlapping-bucket conveyor in tunnel of the Pullman Company boiler house. Both installed by the Link Belt Co.

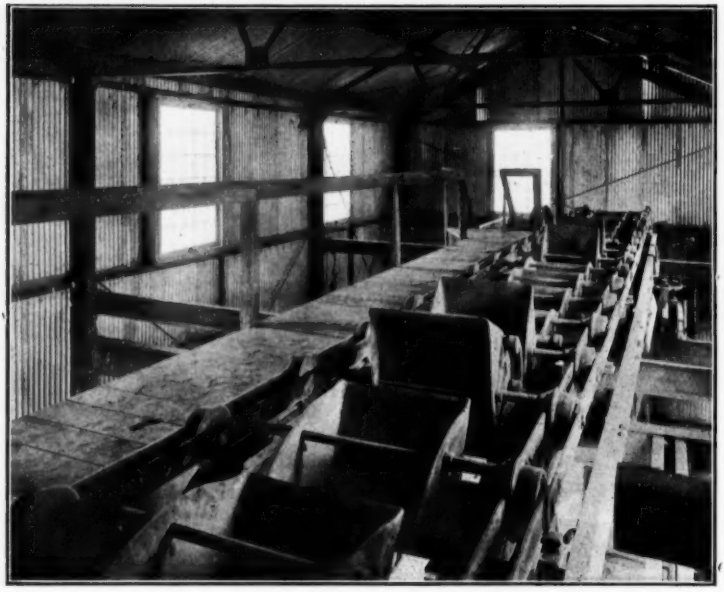
track. The electric hoisting apparatus may be either non-automatic or automatic. In the first, and this applies also to steam, the services of an operator are needed, whereas in the second, the throwing of a switch is all the service needed to start the hoist and return it ready for reloading. The skip is usually lowered into a pit below the floor level, so that material may be easily emptied into it, and is then automatically discharged by upsetting at the upper end of the runway. For charging blast furnaces this system is frequently used, the skip operating on an inclined track. In power houses such a plant is often well adapted for handling ashes, and here the track, or runway, is commonly built vertical. The serious trouble resulting from handling wet or hot ashes is practically overcome by the skip method as, with proper design, the moving parts are kept entirely free from water and ashes.

In one plant equipped with an automatic electric hoist, and handling 36 tons of ashes per day, the charge for power, the company generating its own current, amounts to $1.75 per day. The operation of a steam equipment, taking steam from the main power plant, would cost $4.00 to $5.00 per day.

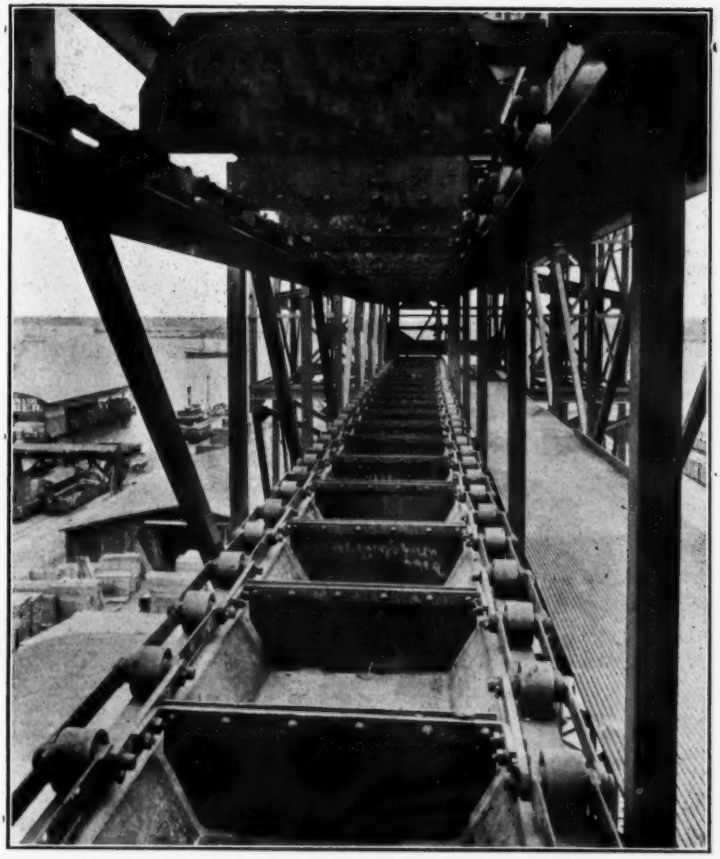
Continuous Handling Machines.

Bucket Elevators and Conveyors comprise, in the continuous handling class, a large percentage of the various systems on the market. The reason for such universal use of the bucket type is primarily its adaptability to varying conditions. Such machines are designed with two objects in view, viz, to elevate the material vertically or to convey it horizontally. These two movements are accomplished either by two independent machines or by one machine designed for the purpose. These elevators and conveyors are made up of a line of buckets, built in an endless variety of shapes to suit varying conditions, attached to or suspended from a continuous belt or one or more continuous chains. In a very common design of bucket elevator either a canvas or so-called rubber belt is used, having the buckets secured to it by means of bolts. This type of elevator is particularly applicable to the handling of broken stone, sand, cement, or any sharp, gritty material, the belt withstanding the cutting action of such materials better in a great many cases than does a chain-type machine. The buckets are of sheet steel or malleable iron. In the handling of wet materials, and particularly where there is a chance for any chemical action, as in ashes or coal, malleable buckets are preferable to sheet-steel ones. So-called "link belts" are extensively used for conveyors and elevators, and the many standard designs afford possibilities for handling almost any class of material.

The Gravity Bucket Conveyor, which may be classed by itself among the bucket machines, is made up of a double strand of chain between which the buckets are suspended on trunnions. The links as made by the different manufacturers vary from 12 inches to about 36 inches in length. The links and buckets are carried by single flange wheels upon a suitable track. There are two types of gravity bucket conveyors, the contact and the overlapping. In the first, the ends of adjacent buckets touch or swing slightly free when the conveyor is on a horizontal run. In the second case, the ends of adjacent buckets overlap about an inch or an inch and a half. A filler, or mechanical device for loading the buckets is commonly used with the contact machine to prevent spilling; the object of overlapping in the other machine is to dispense with the filler. The speed of gravity bucket conveyors ranges from 40 to 60 feet per minute, and they can handle from 35 to 140 tons of coal per hour, depending upon size and speed. The type is well adapted for handling coal, ashes, hot cement clinker, and other bulk materials, and offers certain advantages, chief among which may be mentioned; material carried free



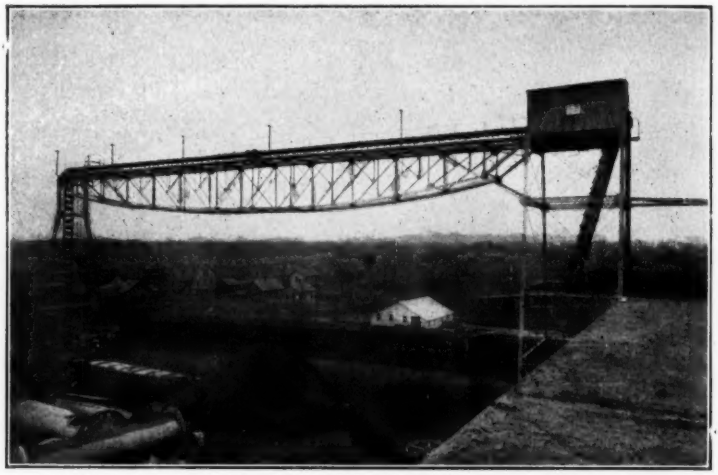
GRAVITY BUCKET CONVEYOR FOR CRUSHED ROCK, NAZARETH CEMENT COMPANY.
The run is 80 ft. horizontal and 60 ft. vertical; buckets 18 by 24 in.; capacity 50 tons per hour. Installed by the Webster Manufacturing Co.



FLIGHT CONVEYOR FOR THE PHILADELPHIA RAPID-TRANSIT COMPANY.
Capacity 100 tons an hour; 860 ft. long. Built by the Webster Manufacturing Co.

from contact with running parts, no dragging of material required, material may be carried both vertically and horizontally by one machine, discharging mechanism is simple, repairs are comparatively low. In carefully operated plants repairs and depreciation should not exceed 10 per cent, being lower than this in some cases.

Flight Conveyors are used for transporting bulk material either horizontally or on an incline. Such a machine consists of endless chain or chains having attached at regular intervals plates, or flights, the whole moving along a continuous trough in which the material is



OVERLAPPING BUCKET CARRIER FOR HOT CLINKERS, CHICAGO PORTLAND CEMENT COMPANY.

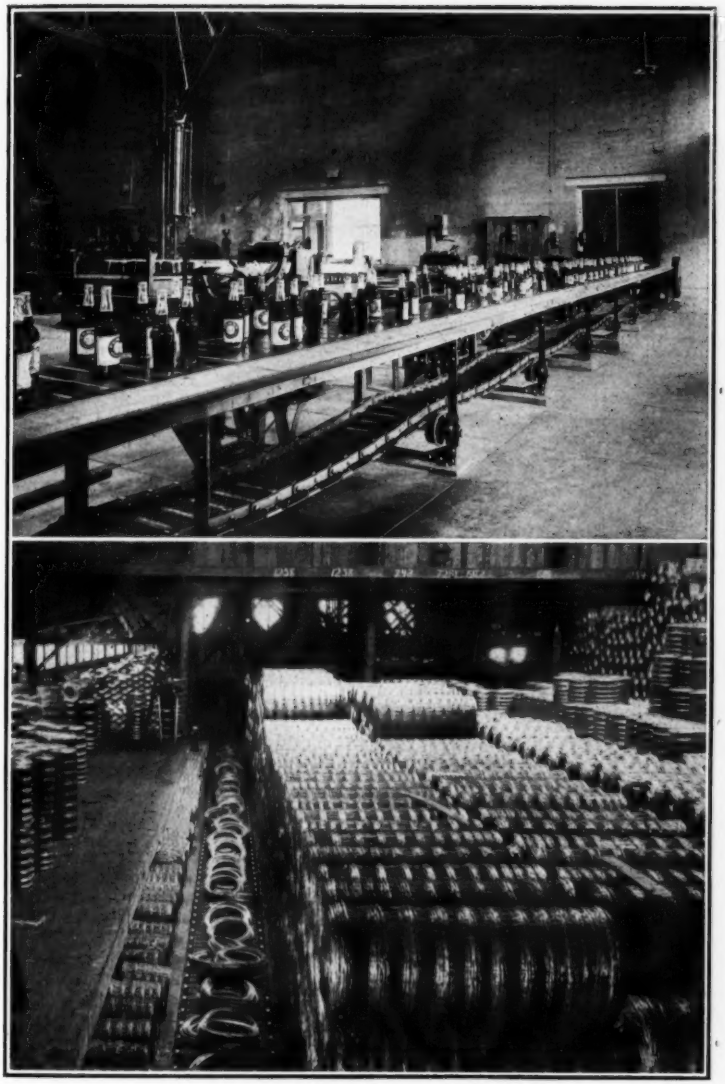
Capacity 40 tons per hour. Installed by the Link Belt Co.

held, the flights pushing the material forward. The flights are supported upon runways by means of wearing shoes, rollers, as in case of roller chains, and wheels. Conditions determine which method to employ, but all things considered the latter method gives the best service, as the principles of design are more nearly correct. The scraping action is necessarily hard on the trough plate, and particularly so with gritty materials, such as sand, or stone. The usual speeds range from 50 to 80 feet per minute. The capacities given in the table, being calculated for a speed of 100 feet per minute, afford a quick means of determining capacities for any given speed.

CAPACITIES OF FLIGHT CONVEYORS.

Material—Coal, weight 50 lb. per cubic foot. Speed—100 feet per minute.

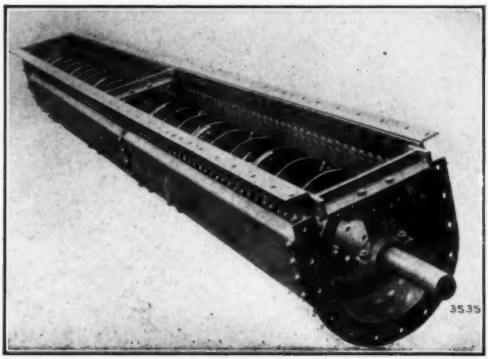
	Horizontal Conveyors.			Inclined Conveyors.		
Size of Flight, Inches.	Flights 16 Inches apart. Tons per Hour.	Flights 18 Inches apart. Tons per Hour.	Flights 24 Inches apart. Tons per Hour.	10 Degrees. Flights 24 Inches apart. Tons per Hour.	20 Degrees. Tons per Hour.	30 Degrees. Tons per Hour.
4 x 10	33½	30	22½	18	14	10½
4 x 12	42½	38	28½	24	18	13½
5 x 12	51½	46	34½	28½	22½	16½
5 x 15	69½	62	46½	40½	31½	22½
6 x 18	....	80	60	49½	40½	31½
8 x 18	....	120	90	72	57	48
8 x 20	....	...	105	84	66½	56
8 x 24	....	...	135	120	96	72
10 x 24	....	...	172	150	120	90



EXAMPLES OF APRON CONVEYOR INSTALLATIONS.

The upper one is a steel-apron conveyor handling bottles at the Frank Fehr brewery, Louisville; the lower is a wood-apron conveyor in the Lamb Wire-Fence Co. plant, Adrian, Mich. Both built by the Jeffrey Manufacturing Co.

Spiral or Screw Conveyors date back to the time of Archimedes who seems to have been the first to make a practical application of the principle. The use is limited to the conveying of the finer grades of coal, sand, cement, grain, or similar materials. The design is simple, consisting of a spiral plate attached to a central shaft, the whole being supported in a box. By revolving the shaft the material resting in the box is pushed forward by the spiral plate which is really a continuous flight. There is the same dragging action in this as in the flight conveyor, and the box lining, usually made of steel curved to proper radius, receives the principal wear. Screw Conveyors are well adapted to confined places, as they occupy the minimum amount of space and require the simplest sort of a drive. They can be operated in either direction, which offers advantages in certain cases. The table gives sizes commonly used with maximum capacities for coal and recommended revolutions.



WATER-JACKETED SCREW CONVEYOR.
For moist sugar. The Link Belt Co.

CAPACITIES OF SPIRAL CONVEYORS.
Handling Fine Coal.

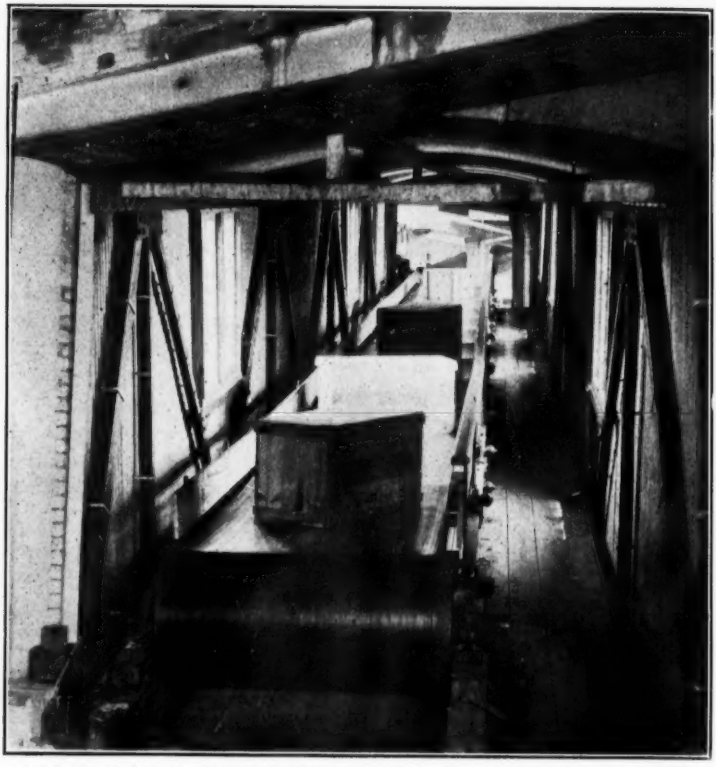
Diameter, inches.	Maximum capacity per hour. Cu. ft.	Recommended revolutions per minute.
4	94	220
6	280	200
9	940	175
12	1860	150
16	4700	130
18	5600	120

The Trough or Pan Conveyor is used principally for carrying hot materials, like spikes, rivets, castings, etc. The successive pans, attached to the conveyor-chain links, overlap, forming a continuous trough. The whole is supported by wheels running on a suitable track. The conveyor is also used for large material like run-of-mine coal. It can not be classed among the higher grades of machines but is suitable under certain circumstances.

Belt Conveyors for the economical handling of various classes of materials have come into considerable prominence during the past few years. They are extensively used for transporting coal, lime, cement, sand, ores, bags, boxes, etc. The first systems of this type consisted of an endless cotton belt running flat on a series of wooden idlers, and were employed for carrying grain. Concentrators, or dish-shaped rollers, were then introduced, as a precaution against the spilling of materials over the edge. These rollers tilt the edge of the belt slightly, giving it a trough shape. The next step in the development of the belt conveyor, was the introduction of the troughing idler, a refinement upon the concentrator principle. The belts are made of cotton duck, usually 4 to 6 ply, protected against wear by the application of coatings of various kinds, rubber and certain oil compounds being commonly used for this purpose.

BELT-CONVEYOR ON A STEEP INCLINE, NATIONAL LEAD COMPANY'S ATLANTIC WORKS.

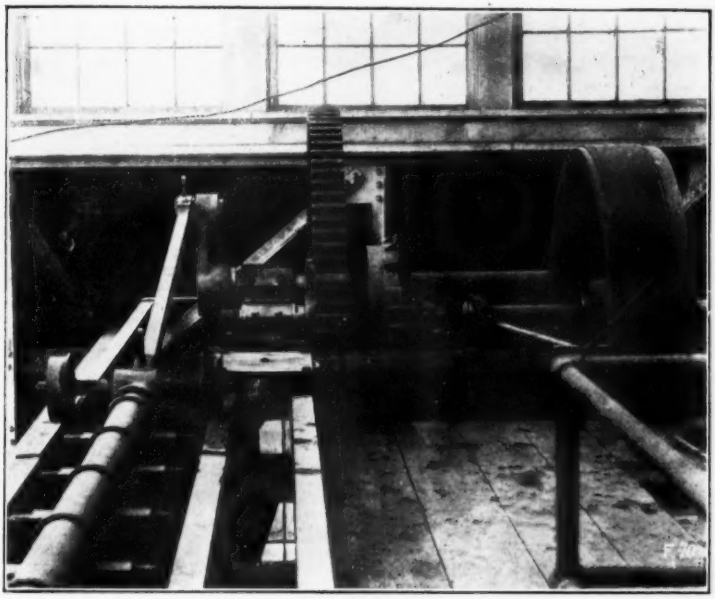
Installed by the Robins Conveying Belt Co. to carry coal; 18-in. belt, about 150 ft. centers. Lower part on an incline of 20 degrees with horizontal, upper part level, with tripper; capacity 90 tons coal per hour.



BELT CONVEYOR FOR HANDLING BOXES, PLANT OF THE SINGER MANUFACTURING COMPANY.
Installed by the C. W. Hunt Co.

Conveyors of this type are used to transport material both horizontally and on an incline. The angle of inclination depends upon the nature of the material handled, but experience has shown that the maximum inclination under favorable conditions is about 23 degrees. The driving pulley and accessories may be located at the head end, at the tail end, or at any intermediate point. This flexibility offers certain advantages as the position of the drive may thus be controlled by the location of the source of power, by structural considerations, and by the fact that more than one conveyor and possibly other machinery are to be driven from a central point.

The belt may have a speed of from 200 to 700 feet per minute, and capacities depend upon width and speed. The table gives capacities of conveyors usually employed.



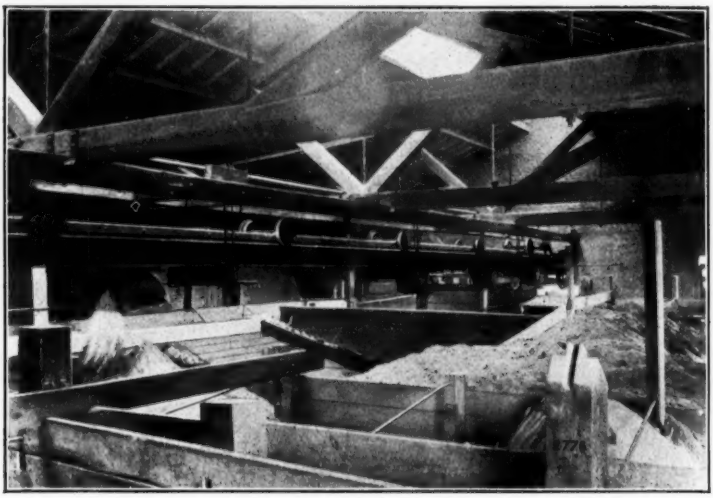
DRIVING END OF RECIPROCATING CONVEYOR, WESTINGHOUSE AIR BRAKE COMPANY.
Installed by Heyl & Patterson.

CAPACITIES OF TROUGHED BELT CONVEYORS.
Material—Coal, weight 50 lb. per cubic foot.

	Speed 200 feet per minute.		Speed 400 feet per minute.		Speed 600 feet per minute.	
Width of conveyor belt.	Largest size of cube which can be carried.	Tons per hour.	Largest size of cube which can be carried.	Tons per hour.	Largest size of cube which can be carried.	Tons per hour.
12	2 inches	6	½ inch	16	¼ inch	22
16	3 inches	16	1 inch	34	¾ inch	50
18	4 inches	20	1½ inches	45	1 inch	70
20	5 inches	30	2 inches	60	1 inch	100
24	6 inches	50	3 inches	100	1 inch	190
30	7 inches	100	4 inches	200	2 inches	360
36	9 inches	180	6 inches	340	2 inches	600

The main item of expense in the up-keep of this system is that of renewal of the belt, and all possible means should be employed, by improvement in design or care in operation, to increase its life. With ordinary care and attention a good grade of conveyor belt should last from two to five years.

Reciprocating Conveyors are used in foundries, glass works, and similar places where perfect mixing of several ingredients into batches is desired. Such a machine consists of a rectangular trough, built of



RECIPROCATING SAND CONVEYOR, FOUNDRY OF BENJAMIN ATHA & COMPANY.
The sand is fed to conveyor at the rate of 37 tons an hour by a Link Belt conveyor outside the building. Installed by the Link Belt Co.

wood, or steel, with bottom gates at required points for the discharge of material. The flights, which push the material forward, are attached to a rigid member, consisting usually of a wrought-iron pipe extending the full length of conveyor. This pipe is supported at intervals by guide frames, or by trucks which keep it in position. It is given a reciprocating motion by means of a crank and pitman attached to one end, and driven by suitable mechanism. On the forward motion the flights are held vertical, and push the material ahead, but on the return, being hinged, they ride freely up over the material.

There are many machines and combinations of machines which may be installed for doing any special sort of work and it is the province of the engineer to analyze the various schemes which the manufacturers submit as best suited for the situation. The depreciation of most material-handling equipments is necessarily high—that is, high for example when contrasted with the same item in the operating cost of steam engines, and I believe that in the majority of cases, an increase in the first cost which will materially decrease this charge is warranted. Careful attention on the part of operating engineers also will often prevent needless and expensive breakdowns, the immediate effect of which, aside from the expense to the owner, is a condemnation of the manufacturer and of the machine, including the meting out of a share of blame to the consulting engineer.

HOISTING MACHINERY FOR THE HANDLING OF MATERIALS.

By T. Kennard Thomson.

If any justification be needed for the space here given to the discussion of machinery for hoisting and handling, it is amply supplied by these papers themselves. To some extent, the field of hoisting appliances must overlap that of conveying devices already reviewed; but Mr. Thompson invests the description and analysis with additional interest by treating it in connection chiefly with a distinctive range of work—that of construction, rather than of production. And he brings out impressively that here as elsewhere in the domain of modern enterprise, economy in unit costs and maximum of output can be secured only where intelligent and well-advised use is made of the mechanical facilities afforded for the handling of materials. Mr. Thomson's review will be continued through two succeeding installments.—THE EDITORS.

THE last fifteen or twenty years have witnessed so vast an improvement in hoisting machines and their development as labor-saving devices in so great variety that many books could be filled with illustrations of the various kinds of machines. All that is possible in a magazine article is to refer to the general types and give a few examples of each, showing their range of work and cost.

A discussion of hoisting machines, by convention, must begin with the pyramids of Egypt, and yet no one has been able to decide how the enormous stones were handled, for, even allowing for the vast army of men, some sort of mechanical contrivance must have been used. One theory is that as each course of stone was laid, a sand embankment was built around it with long easy slopes so that the stones for the next course could be pushed up on rollers and slid into place without any actual lifting, and so on, the pyramid being in fact buried as fast as it was built, until the top was reached, when the stupendous job of removing the sand embankment was commenced.

This might account for the vast army of laborers used; for instance, it is said that in building the great pyramid of Cheops 100,000 men were employed for 30 years, although the quarry from which the stone was obtained was only 3,000 feet from the pyramid.

The City Investing building, the largest sky scraper in New York, happens to be nearly the same height as the pyramid. If we required the same number of days' labor for this building, which takes a year

SHORES USED IN BUILDING OPERATIONS, CORNER OF MAIDEN LANE AND WILLIAM STREET, NEW YORK.

Some of the strongest shores ever put up to sustain a building. At the bottom may be seen the screw-jacks by which they were adjusted. The Foundation Co., contractors.

to erect, as the Egyptians took, we would have 30 multiplied by 100,000, or 3,000,000 men working every day for one year on this one building. Imagine a number of men equal to almost the entire population (including men, women and children) of New York City, trying to reach the corner of Broadway and Cortlandt Street every morning. Even if they got there, there would remain the impossibility of finding

standing room, let alone working room for them, or of providing a commissariat or hygienic department. Against this 3,000,000 men working every day for one year, the average number on the City Investing building would not exceed 2,000 men a day, while the maximum would probably never reach 3,000. While in some ways it is not fair to compare a stone structure with a steel building, still there is no doubt that the chief difference is due to the improved machinery, the greatest strides in which have been made within the last twenty years—many kinds of work now being handled in from one-half to one-third the time that was required two decades ago.

As we have seen, it is conceivable that the pyramids might have been built with no other mechanical aid than an ordinary crowbar or lever and, perhaps, a screw or hydraulic jack. These still remain the fundamental mechanisms whose principles, once thoroughly understood, make perfectly clear the otherwise puzzling theory of bending moments, balanced forces, etc. While the principle of the lever was being worked out and applied and many complicated forms were being evolved, the principle of the screw was probably not far behind. The screw combined with the lever is one of the most powerful and at the same time slowest of hoisting implements—for, as the nut revolves it is forced up the incline of the screw, about 60 degrees, and if the diameter of the screw is ¼ of an inch the nut has to be turned around 20 times to move one inch vertically. If the diameter is 6 inches, 2¼ revolutions are required; if the power be applied by a man at the end of a 5-foot wrench by hand, to raise the nut of a 6-inch screw 1 inch he would have to walk 2¼ times around a circle of which the diameter is 10 feet, which is equivalent to a travel of more than 70 feet. With a 1¾ inch screw he would have to go around 5 times, or cover about 157 feet to raise the nut 1 inch, and, as the power he applies to the screw jack so slowly is multiplied by the radius (length of the lever), in this case 5 feet or 60 inches, and divided by the radius of the screw, it will easily be seen that a force of 100 pounds would raise over 3 tons, less the friction. As this movement is so slow, it is possible (by placing an immense number of jacks under a building), to have one man go from jack to jack, giving each a slight turn each time, and thus unaided to lift the entire building gradually from its foundations. As a matter of fact, we all have probably seen buildings thus raised, sometimes only a fraction of an inch or hair line, until new foundations are placed under, and at other times enough to allow the building to be moved to another site.

One of the most interesting examples of this was the raising and

moving of the Brighton Beach Hotel, a building 460 feet long, 120 feet wide and from two to five stories high. After it had been jacked up by one thousand two hundred screw jacks, twenty-four tracks were laid under it and one hundred and twelve flat cars were distributed under the building. A system of beams transferred the weight of the hotel to these cars, which were so connected by means of block and tackle to four or six railroad locomotives that the entire building was moved nearly 600 feet without injury, although at one time the engines pulled at the rate of 8 miles an hour; the block and tackle were made to act like the whiffle tree of a carriage, so that when the locomotives pulled the strain was distributed evenly over the entire area of that big frame structure, which was thus saved from the encroachment of the ocean.

NEEDLE BEAMS FOR UNDERPINNING THE NEW BUILDING AT 166 BROADWAY, NEW YORK.

Showing the screw-jacks for taking up the strain. Clinton & Russell, architects; the Foundation Co., contractors.

More powerful than the screw and at the same time much quicker is the hydraulic jack—also long known. The principle on which it works might be explained by taking a box full of water, having its top arranged as a piston, and a small pipe containing another piston connected with the side or bottom of the box. Now we know that if the area of the big piston is one hundred times the area of the small

piston, then the weight lifted by the big piston will be one hundred times that applied to the small piston; but, as this lifting can only be accomplished by forcing water or other fluid from the pipe into the box, it is obvious that at each stroke the little piston must move one hundred times as far as the big one. Here again we see that a very small force can raise an enormous load, but only by moving through a proportionately greater distance.

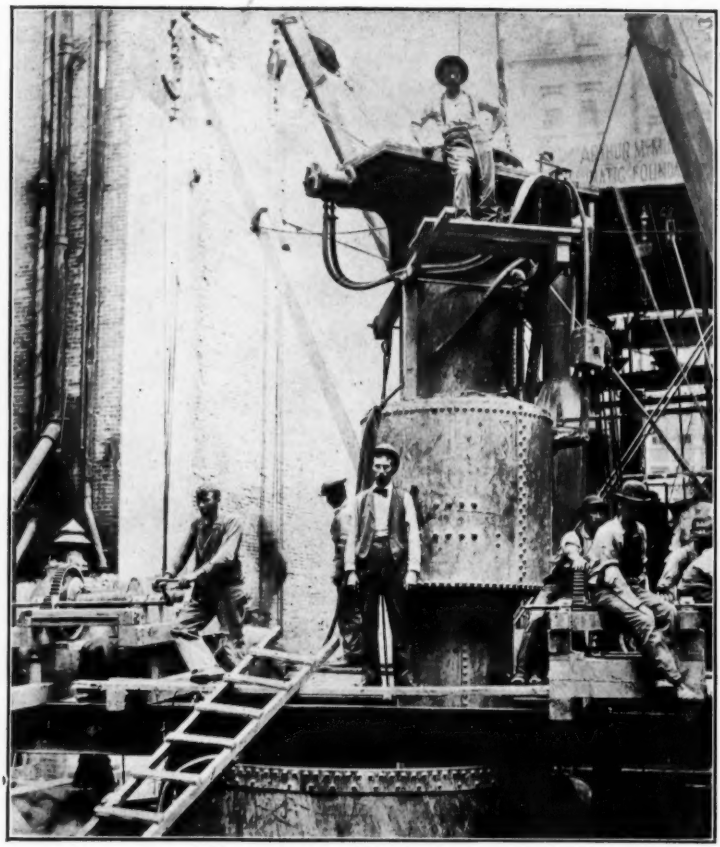
By using pumps, levers, etc., this principle is used for many purposes, such as operating elevators, launching vessels, forcing water through fire hydrants, operating cranes, etc. In launching ships, enormous pressures are sometimes used and water has even been forced to ooze through cast-iron plates 6 inches thick. Not only can heavy objects be thus raised slowly, but the reverse must also be true, and a great force can be used slowly to raise a small weight very quickly.

In underpinning a building (an everyday occurrence in New York now, owing to the new foundations being lower than the old—not to mention tunnels, etc.), a multitude of screw jacks are sometimes used, or in other cases a much smaller number of hydraulic jacks, the most common commercial sizes now used in New York running from 4-tons to 200-tons capacity. They are so designed that one 150-pound man can raise 10 tons 1 foot in about 1½ minutes, or 100 tons in 15 minutes. In forcing underpinning caissons 3 feet in diameter under the walls of a building, we usually use one or two jacks of from 60-tons to 100-tons capacity each; but I once stopped a foreman who was trying to shove a caisson down with four jacks aggregating 320 tons, for fear that he would injure the superimposed building, the cylinder or caisson having got jammed on the way down.

Screw jacks cost from $10 apiece up, while a good 60-ton hydraulic jack is quoted at about $200 and a 200-ton jack at from $500 to $600.

As the ancients probably understood levers and jacks, they were able by taking infinite pains and time and plenty of cheap labor to move almost anything. They were no doubt content; but in this age of rush, labor unions, and extreme pressure of time and cost, even a fraction of a minute on a single operation means a great deal of time and money saved or lost. This is probably more obvious in handling and printing the daily papers than in contract work, but it is none the less vital to the contractor.

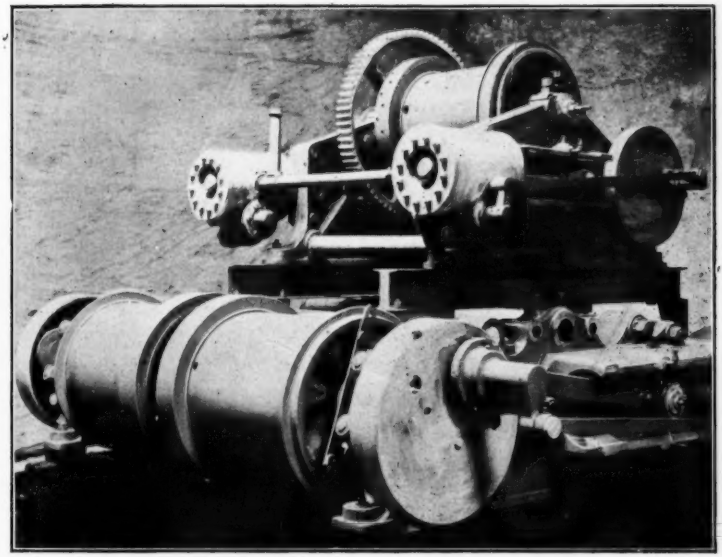
Did the genius who invented the cart wheel also invent the pulley block, and which came first? Of course the first pulley consisted of a single wheel, and merely overcame friction without any increase in



CRABS USED FOR PULLING DOWN THE CAISSONS IN FOUNDATION WORK.

At the Commercial Cable building, New York; Arthur McMullen & Co., contractors.

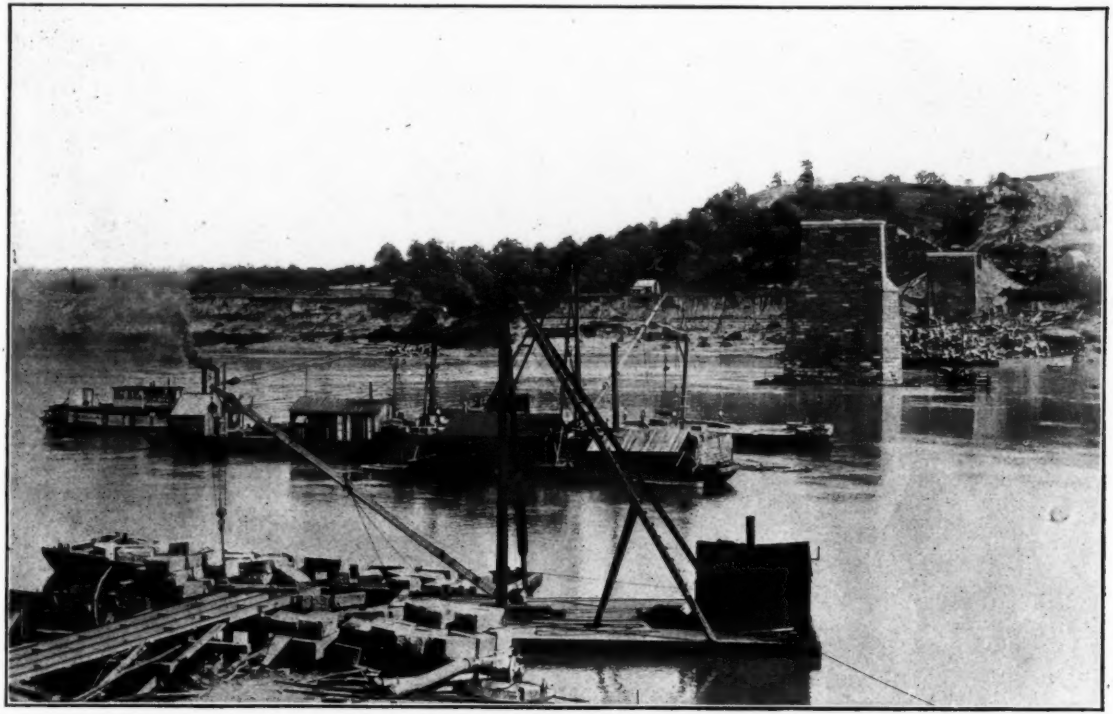
power. By using two blocks with one sheave each the power is doubled, and it can be doubled again as often as the sheaves or blocks are doubled; but as before, the applied force has to travel twice as far when the lines are doubled up, and so on each time, with slight allowance for friction, the blocks and sheaves being regulated according to the work. For instance, in caisson work, when we have to lift heavy parts of machinery, say from 15 to 20 tons, the blocks are doubled up and the ponderous weights are carefully hoisted; but when



SUPERIMPOSED ENGINE FOR HOISTING. THE POWERFUL AND EFFICIENT SUCCESSOR OF MULTITUDES OF WORKERS EXERTING HAND POWER.

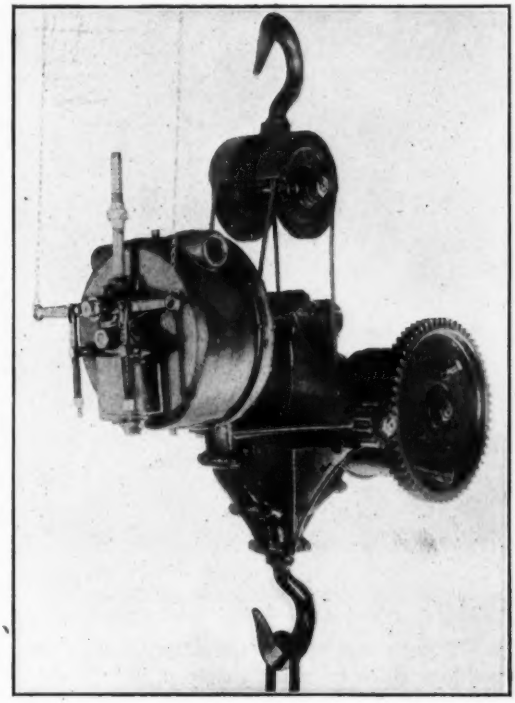
Double-drum double-cylinder direct-connected hoisting engine and single-drum double-cylinder traversing engine. Built by the C. W. Hunt Co.

we want to take a half-yard bucket of material out of a caisson the hoisting engine does not need the assistance of any pulley block, but great speed is required, so the rope is simply run over a single sheave and attached to the drum of the engine and by this means a bucket of materials can be taken out of a caisson air chamber 80 feet below ground, passed through the lock (only one door of which can be open at a time), lifted 20 or 30 feet above ground, emptied by being turned upside down, and returned through the lock to the air chamber twenty times an hour, as long as the men will fill the bucket quickly enough. On caisson work, as on most important contract work, the speed with which the material can be handled means thousands of dollars to the contractor or owner, for there is always an item called "general expense" covering the wages of superintendents, foremen, fuel, etc., amounting from one hundred to many hundreds of dollars a day. This expense runs right along practically unchanged whether a hundred or several thousands of yards of material are moved.



DERRICK BOATS USED IN BUILDING THE NORFOLK & WESTERN RAILROAD BRIDGE OVER THE OHIO RIVER AT KENOVA, W. VA.
A small one is moored in the foreground, and a larger one may be seen in the stream. This was used for building a pier 103 ft. high.

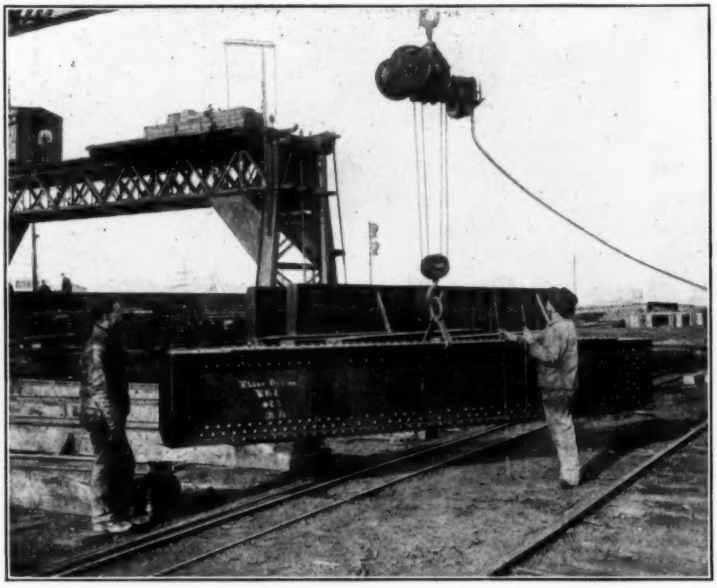
Probably not long after the invention of blocks with one or more sheaves each, the uncertainty and labor of continually pulling on the rope, whether the load was being lifted or simply held suspended, became apparent; and some wide-awake chap thought of passing the end of the rope over a drum, giving the rope two or three turns around (thus obtaining a better purchase) and then fastening the end of the rope to the drum and adding a crank or handle, thus saving several men. Continual holding of the handle, however, was still required, until the ratchet wheel and pawl were added, similar to that used for brakes of a railroad train. The next step was to place the drum on a frame and call it a "crab." This is still used on small jobs, especially in building construction, in which case the crab is usually attached to a two-legged frame called a house derrick. A much more advanced "hand" machine is the triplex block, which is geared to raise heavy weights by hand power and automatically checks itself; though a little slow it is always in place ready for use. A further step in the application of this principle has produced the compressed-air hoists, which are built of various sizes to lift from ½ ton to 5 tons, the small size costing $135 and the 5-ton $275. They are high-duty pneumatic motors geared to hoisting drums and generally operated under



AN AIR-MOTOR HOIST.
The "Imperial," made by the Ingersoll-Rand Co.

80-pounds air pressure. The range of speed is quite wide and the motion is controlled by worm gears instead of brakes.

It is stated that a 1-ton hoist with 80-pounds gauge pressure can lift 30 feet a minute with a consumption of 30 cubic feet of free air, while the 5-ton hoist can lift about 7 feet per minute using 45 cubic feet of free air; so where they are in constant use or the compression plant is used for other purposes, the cost of running the hoist is trifling. Dr. Frank Richards some time ago published an estimate that at 100-pounds gauge pressure, compressed air costs 5 cents per 1,000 cubic feet of free air. Triplex blocks, pneumatic hoists and other similar devices usually run on overhead trolleys and are more often used in shops than as shown in the cut below lifting a heavy girder in the yard.



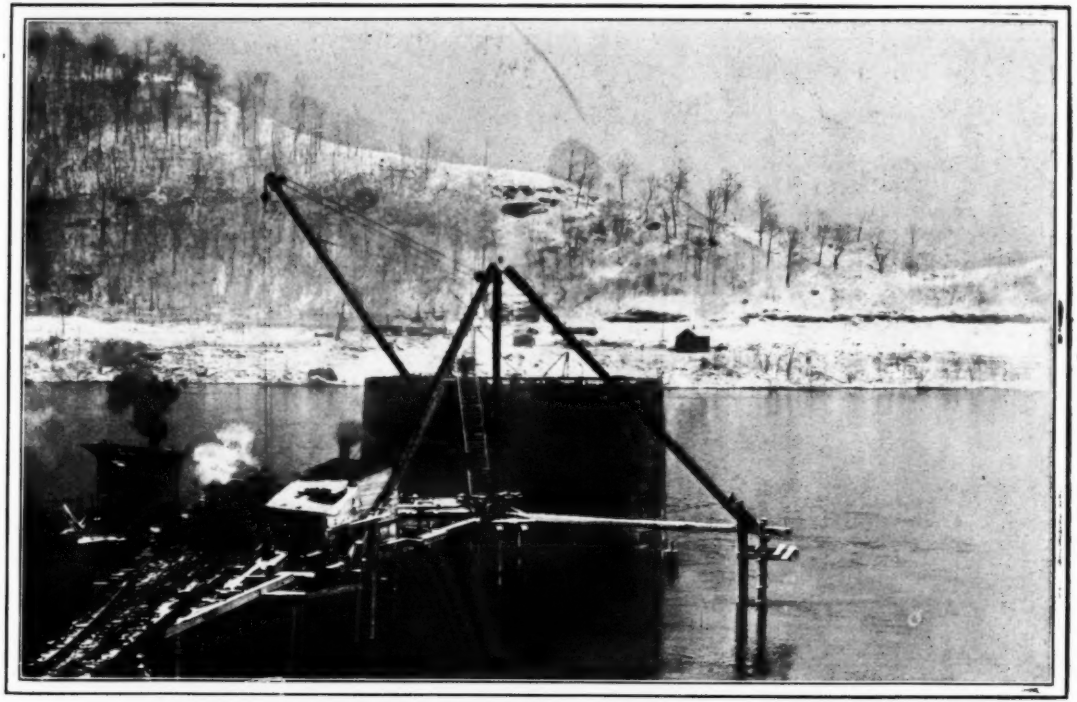
AN AIR-MOTOR HOIST LIFTING GIRDERS IN A BRIDGE-BUILDING YARD.

The hoist shown is a "No. 10 Imperial," made by the Ingersoll-Rand Co. The air-supply and the mode of control from the ground are clearly indicated.

Before going on with the description of up-to-date steel hoisting machines which are rapidly supplanting the old-style wooden derricks, we might briefly refer to the latter, which have been so familiar on building and other construction.

ERECTION OF THE ELEVATED RAILROAD STRUCTURE ON FLATBUSH AVENUE, BROOKLYN.
Showing the derrick traveler used by the American Bridge Co.

Out in the country where space is not limited, the cheapest to erect and easiest to handle is probably the well-known guy derrick, consisting of a vertical mast on a simple foundation with a ball and socket contrivance at the base to permit the mast to revolve; but while this contrivance is simple, it makes all the difference in the world whether it is well designed or not, and many are not. The top of the mast carries a gudgeon pin some 4 inches in diameter and 4 or 5 feet long for a big derrick, over which a thick circular plate with five or more holes for the guy wires is dropped. A 2-ton derrick usually has about five ¾-inch diameter galvanized-iron guy wires,



A STIFF-LEG DERRICK ON PILES, FOR CONSTRUCTION OF THE OHIO RIVER BRIDGE AT MINGO JUNCTION, OHIO.
Arthur McMullen & Co., Contractors.

at least three times as long as the mast; if the locality permits they can be made much longer to advantage, while in some recent sky scrapers very short guys have been used, 25 to 50 feet from the mast; in this case considerably more than five guys have been used, and of course the range is very limited, as the boom could not be swung under the wires except when raised as high as possible. The boom usually fits into the socket of a casting attached to the foot of the mast, and a pin connection permits the boom to be raised or lowered while the mast revolves, which latter motion is usually obtained by means of a bull wheel 8 to 12 feet in diameter, around which a wire or hemp rope is run, the ends being passed over the drums of the hoisting engine.

The derrick irons for a 2-ton guy cost about $90, and a good engine with a 3,000-pound pull, 6¼ by 8-inch double cylinders, friction drum, pumping gear, and boiler, cost about $1,200; and, of course, less complete engines can be had for less money.

The cost of the timber and framing and hoisting wires (½-inch diameter) would vary greatly according to locality.

STEEL-DERRICK HIGH-SPEED SAND-HANDLING PLANT AT TULSA, OKLAHOMA.

For transferring sand from barges to cars. Steel derrick; bucket 2 cu. yd. capacity. Handles about 1,000 cu. yd. a day at a cost of about 1 ct. per cu. yd. under continuous operation. Designed and erected by the National Equipment Co.

A guy derrick for 20 tons generally has seven 1⅛-inch galvanized wire guys, derrick irons costing some $360; a double cylinder, friction-drum engine with boiler and pumping gear, the cylinder being 8½ by 12 inches, and the engine having a pull of 10,000 pounds and costing complete about $2,400. The hoisting rope is usually ¾-inch diameter.

A DERRICK WITH RIGID ARM AND TROLLEY, AT WORK BUILDING A WALL AT OSSINING, N. Y.

Mast 10 by 10 in., 50 ft.; trolley beam, 10-in. I beam 20 ft. long, 20 ft. above foot block. Crab had two drums, one for hoisting and one for trolley, with reversible rotary engine. Made by Dake Engine Co., Grand Haven, Mich. Derrick cost $500. Ford & Waldo, contractors.

Where the confined space does not permit a guy derrick, the next best thing on temporary work is a stiff-leg derrick. For ordinary contract work where 2 cubic-yard buckets are used for handling material, these are generally built with masts from 12 by 12 inch to 18 by 18 inch timbers, 20 to 45 feet high, and two stiff legs of 12 by 12 timber placed at right angles to each other and inclined vertically about 45 degrees, or very often 10 inches horizontally for each foot vertical. The top connection is made with a goose neck—a heavy steel bent plate some 10 inches wide and 2 inches thick, with about 6 feet bolted to the stiff leg, and a little less than 2 feet of the plate bent so as to fit horizontally over the gudgeon pin.

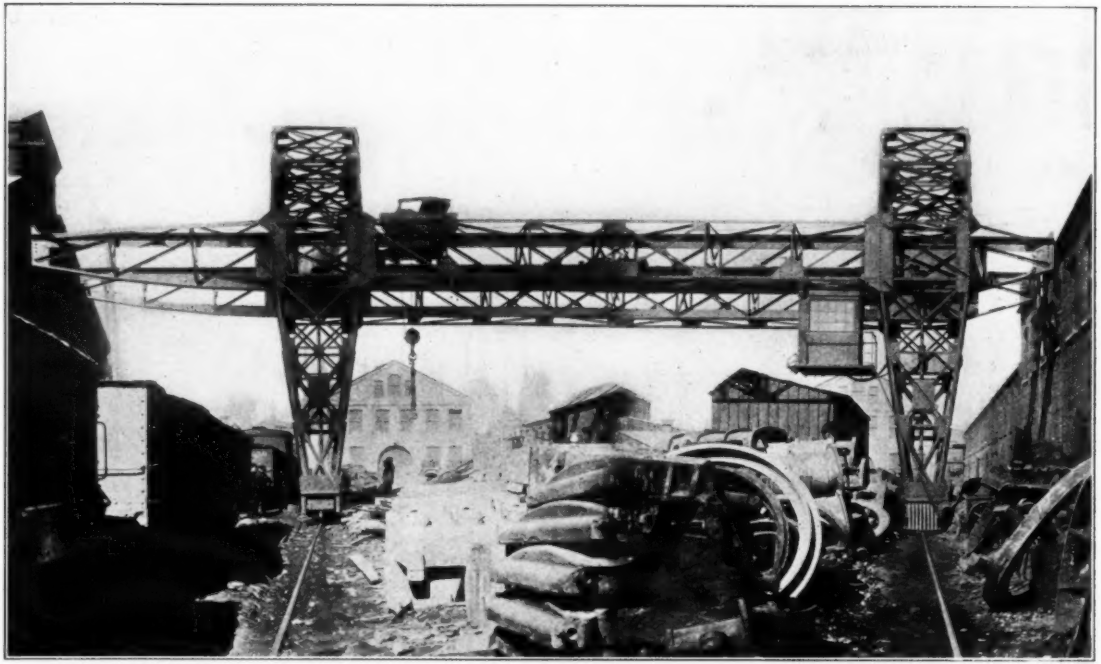
The goose neck was usually the weak point of a stiff-leg derrick, and in consequence they were made very heavy and of the most expensive iron, steel being too unreliable for such heavy forgings; many have now discarded that form of construction entirely in favor of built up steel caps for mast and stiff legs. From under the mast a 12 by 12 sill is usually run to the foot of each stiff leg, to which it is rigidly connected, as well as to a platform carrying a dead weight of stone, pig iron, or other weight, necessary to prevent the derrick from overturning. In places where the derrick rests on some stable structure, it is bolted to this instead.

The irons for a 2-ton stiff leg cost about $130 and a high-grade engine complete with boiler, etc., as for the guy derrick, about $1,200; and a 20-ton derrick would also require the same engine, boiler, etc., as a guy—$2,400—and have iron fixtures costing about $570. These are commercial sizes, sold by regular manufacturers; but many contractors have learned by sad experience that a poorly designed derrick and improving for years, and which, in a few cases, may cost less than the above, though usually they cost much more. Nearly all contractors have learned by sad experience that a poorly designed derrick is a very expensive investment, as a single accident often costs a good many times as much as the derrick itself.

In many cases neither stiff-leg nor guy derrick can be used, and some combination has to be designed to fit the conditions; an example is shown opposite, being a combination of both with a gantry crane which was used by Ford & Waldo on their contract for the New York Central Railroad at Ossining. A boom swinging across railroad tracks should never be allowed, as it is always dangerous and has been the cause of many accidents, and this is probably why the contractors omitted the boom in this case, putting in instead a 10-inch I-beam trolley runway 20 feet long and 20 feet above the foot block. The crab had two drums, one for hoisting and one for moving the trolley, and was operated by a Dake reversible rotary engine occupying no more space than an ordinary crab handle, the whole outfit costing about $500.

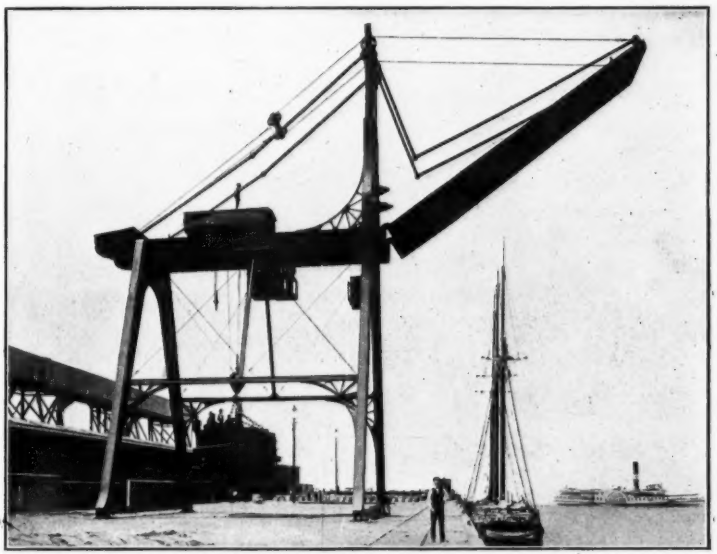
Some contractors who still stick to the "big stick" or wooden derricks get all their pine or fir masts and booms by the car loads direct from Oregon, the forests there supplying the best material obtainable.

Ordinarily stiff-leg derricks are sometimes mounted on trucks and called travelers; but as a rule travelers are more elaborately and compactly designed and have from one to four booms. A heavy four-boom traveler designed to lift 20 tons per boom has been built in New York



A SPECIAL DEVELOPMENT OF THE TRAVELING CRANE. GANTRY CRANE WITH CANTILEVER EXTENSION, ILLINOIS STEEL CO., CHICAGO.
Center to center of rails 56 ft.; extensions 28¼ ft. on one end and 12¾ ft. on the other; 15-tons capacity. Uprights are so constructed as to permit the trolley to travel the full length of the girders with its suspended load. Niles-Bement-Pond Co.

for $3,000; this did not include the engines, boilers, and hoisting tackle, which were complete for each boom. These four-masted travelers are now frequently used in New York city, the latest improvement being the substitution of steel for wood throughout.

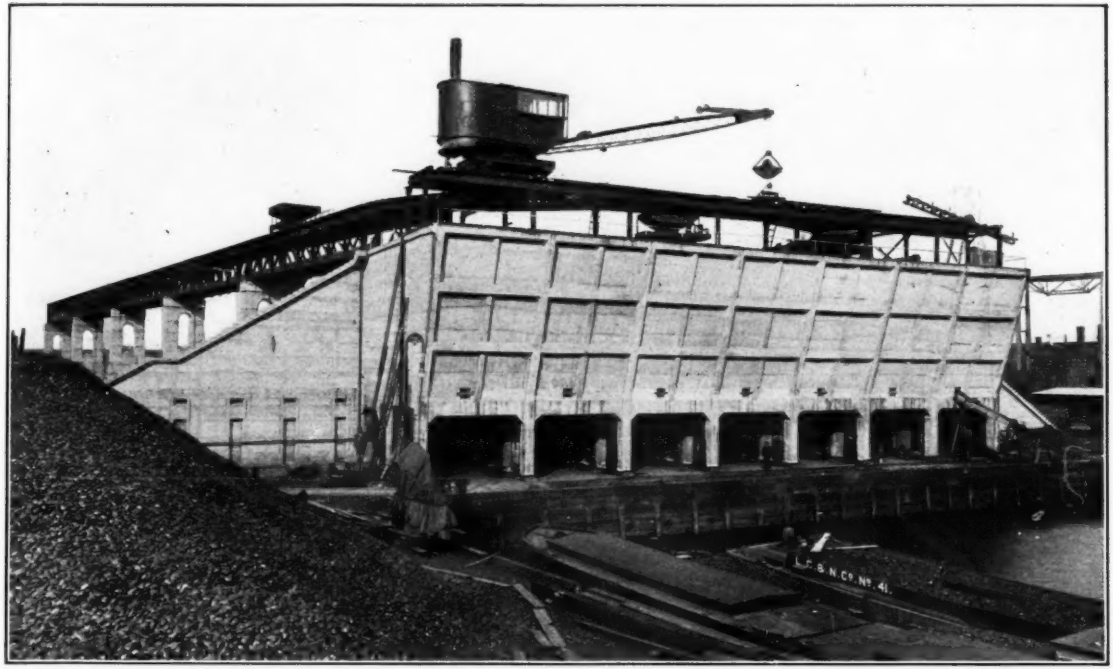


FOLDING-BOOM STATIONARY-JIB 30-TON GANTRY CRANE FOR CHESAPEAKE & OHIO RAILWAY, NEWPORT NEWS, VA.

Width at bottom 40 ft.; height from top of rail to bottom of trolley-track girders, 44 ft. 10 in.; total height 78 ft.; length of boom 51 ft.; total length of trolley-track girders 105 ft. Would cost about $35,000. Installed by the Wellman-Seaver-Morgan Co.

A very neat steel derrick was recently used for building the concrete steel warehouse for Montgomery & Ward in Chicago. It had a steel frame mast 135 feet high, revolving inside of a 10-foot square steel-frame tower 80 feet high, above which an 85-foot steel boom was attached to the mast; it was capable of lifting 12 tons anywhere within a complete circle the diameter of which was 170 feet. It had a vertical range of 150 feet, so that it could lift an object from the ground to 15 feet above the roof, and was so arranged that the 10-foot square tower fitted into a single floor panel, the guy wires being moved as required. As the entire building is 750 feet long and 270 wide, several of these derricks were provided for, saving an immense amount of time, shifting derricks, etc.

The introduction of steel cranes marked the greatest advance



LOCOMOTIVE CRANE AND TRESTLE FOR UNLOADING COAL FROM BOATS, LEHIGH COAL & NAVIGATION CO., PHILADELPHIA.

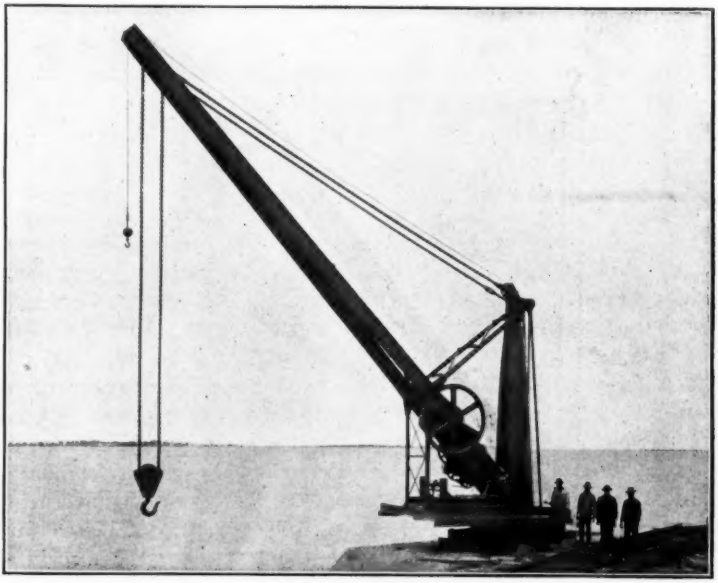
The crane unloads the boats and discharges direct into bunker or into an electric hopper car depositing on ground storage piles under the trestle. The car travels between the girders and the crane on top of them. Coal is reclaimed from the ground by the crane operated from the trestle, the car carrying the coal to bunker. Capacity 60 tons per hour, operated by two men. Crane furnished by R. H. Beaumont & Co.

in labor and time-saving devices, in the shop, field, and on the wharves, etc. Their value was appreciated in England earlier than it was in the United States—especially that of the three-motor electric traveling cranes. At first American contractors imported some of the British machinery, but it was soon found to be not adapted for the rough and heavy work in the United States. The imported cranes were strengthened up where they were weak and lightened where unnecessary material had been used, and while they have been used, and while they have been improved so that often little resemblance to the old remains, the improvement is still going on every day. There is still much room for improvement, not only in the design of the machines but also in the selection of the proper machine in the proper place, in nearly all classes of work, and in many cases this is so obvious that it seems a criminal waste of time and money to continue using manual labor or inadequate or antiquated tools. Very few wharves or freight depots, for example, are adequately fitted up, and hence not only is the direct cost much greater than it should be, but also the indirect cost due to demurrage, etc. A case in point:—an enterprising manufacturer had convinced the chief engineer of a railroad that it would pay him to spend $300,000 for plant at a certain terminal, but the chief engineer could not persuade the Board to raise the money; so the manufacturer offered to furnish the money himself and to take a royalty of something like 2 cents a cubic yard on the material handled, which eventually returned to him a far greater profit than he could have made by selling the machines outright.

Contractors for extensive excavations, masonry and such work, are probably the most enterprising in seeking after new methods, for not only do they save several hundred dollars general expense for every day saved, but also the interest on their money; sometimes (I have seen this happen) a single day's delay will cause the completion of the work to be put off for months, on account of sudden floods, ice, etc.

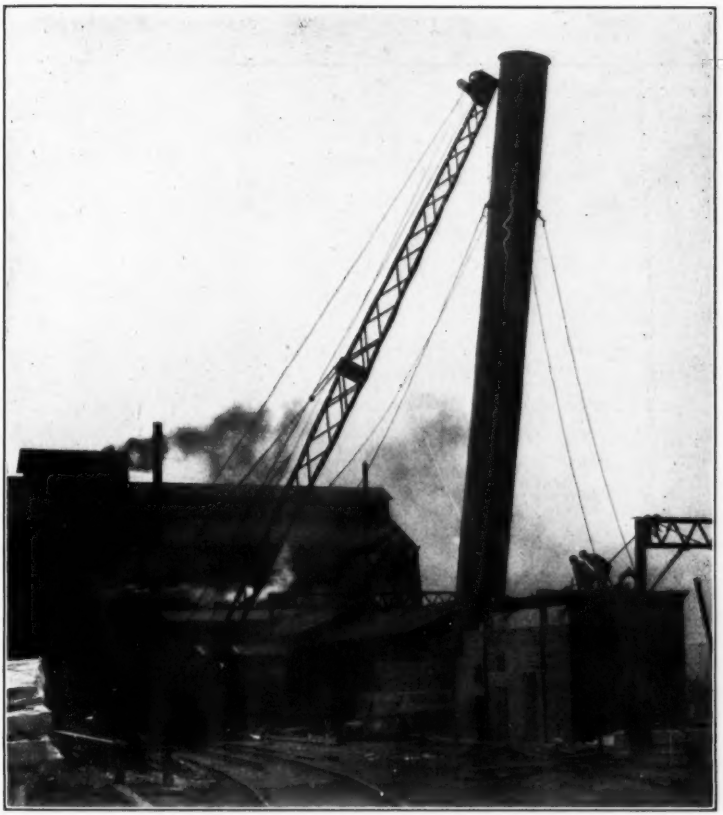
As an example of how cheaply material can be handled:—coal has been taken out of ships and placed on the wharf at the rate of 3 cents per ton, and even this included a sinking fund which would pay for the plant itself in 20 years. Simple as all this may seem, it is astonishing how little the general public and even many engineers and contractors appreciate it. A single case in point:—I have seen a contractor for a whole year work six or seven men on an old-fashioned pulley and crab, and keep five or six men waiting, while

he accomplished work that one man could have done with a good pulley block in much less time, or a stationary hoisting engine could have done even more cheaply, considering the number of men kept idle, etc. The improved methods would have allowed him to make a good profit on his contract, in place of the actual loss he sustained.



A HAND PILLAR CRANE AT THE U. S. NAVAL STATION, PENSACOLA, FLA.
35-ft. radius, 30-ton capacity. The Brown Hoisting Machinery Co.

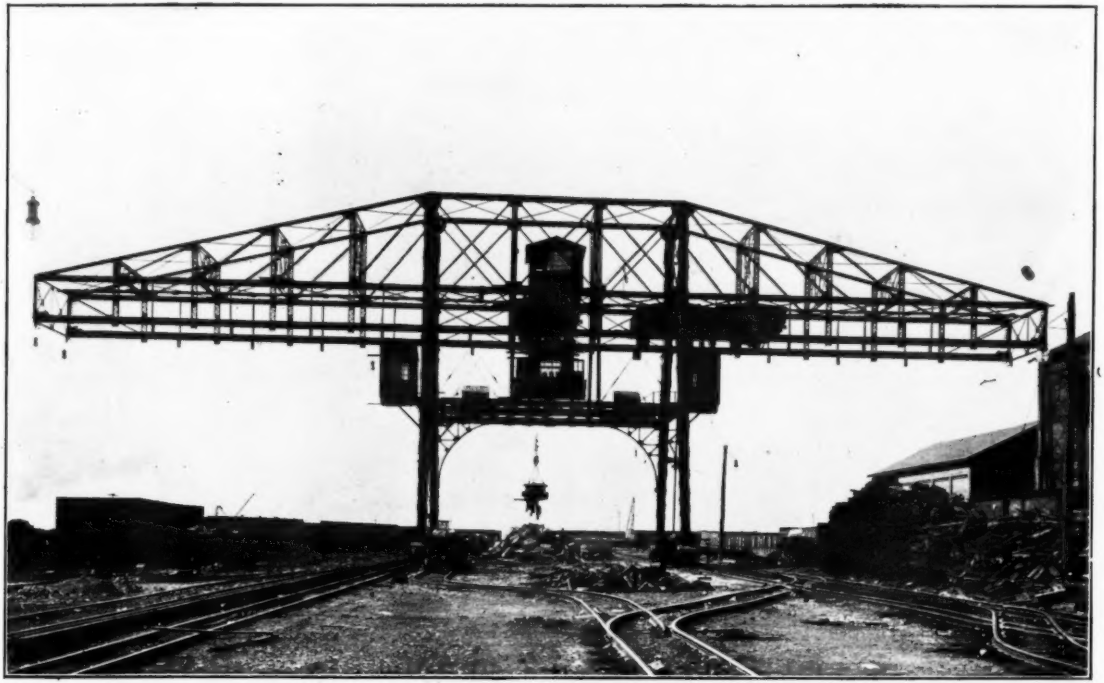
The pillar crane is an improvement or substitute for the old guy and stiff-leg derricks. It is more permanent, and being anchored to the ground the necessity of guys and stiff legs is done away with, economizing room and giving more freedom of work. It is generally made of cast iron or steel, or both, and so pivoted that it can revolve in a complete circle while the boom is raising, lowering, or holding its load. Pillar cranes are made of many capacities, as a rule from 2 to 30 tons, the only limit, in this as in all other cases, being the cost as compared with the cost of some other machine for doing the same work. The cost of a 2-ton hand-power pillar crane with a boom radius of 15 feet is about $450, and for one of the same radius to lift 30 tons, $3,600. A 20-ton electrical-power pillar crane with a 15-foot boom radius would cost about $2,700.



A LOCOMOTIVE CRANE SETTING A 60-FOOT ONE-PIECE STACK.
The Browning Engineering Co.

Pillar cranes are often mounted on flat cars for wrecking purposes, etc. Where the swinging of a boom would interfere with the work the pillar jib crane is used, a horizontal arm carrying a small trolley taking the place of the boom.

In shops, and elsewhere when possible, a plain jib crane is used instead of a pillar jib crane, the top of the mast or pillar being held as well as the bottom—a much more economical arrangement in many places, as the framework of the shop or building provides easy facilities for the top connection; here, however, the range of the swing is often limited to half a circle, especially when set against a wall. In



THREE-TROLLEY GANTRY CRANE FOR LACKAWANNA STEEL CO.

Length of girders 160 ft.; capacity 10 tons. Equipped with lifting magnets for unloading. Such a machine would cost about $30,000. Built by the Wellman-Seaver-Morgan Co.

jib and pillar jib cranes the length of the horizontal arm naturally has much to do with the design and cost of the machine, as has also the load to be lifted; for instance, 2 tons lifted 20 feet away from the mast would cause as great cantilever strains as 4 tons with a 10-foot radius would.

FLOATING CANTILEVER CRANE FOR THE U. S. NAVY YARD, NEW YORK.

100-tons capacity. Pontoon 60 by 100 ft., 11 ft. deep; the rigid legs are far enough apart to pass a load 40 ft. wide from end to end of the cantilever. In addition to water ballast, a 250-ton counterweight traves so as to keep the keel always horizontal. There is no swaying when heavy turrets (for example) are placed. Adjustment can be made to 1/16 in. The crane weighs about 1,200 tons and cost about $225,000. Built by the Brown Hoisting Machinery Co.

The next step from a jib crane is a gantry having two vertical legs or frames carrying an overhead bridge, the legs being arranged to run on parallel tracks, the gauge of which varies from 5 to 200 feet or more; and as the height also varies to clear local objects, it seems almost impossible to give any idea of the cost. Each individual case is a study by itself, so the cost is given only under special photographs.

One of the early very large cranes in America is that at Sparrow's Point, Maryland, built by the Pennsylvania Steel Company to lift 150 tons, the steel used in the construction weighing 775 tons.

Another of these imense hoisters was built to lift the same weight

for the Imperial Dock at Bremerhaven, with a clear height of 118 feet and a horizontal reach of 72 feet, allowing it to pick a 150-ton load off the ships and clear the smokestacks, etc. This contains only 412 tons of steel as compared with the 775 tons of the Maryland shears.

Stationary cranes are operated by hand, steam, electric or hydraulic power. The first is desirable only where the loads are to be moved at considerable intervals and time is a secondary object. Steam is very useful where only one crane is to be run and that steadily, but is inferior to electric or hydraulic power when there are a large number of machines to be worked from the same central station; for it has been found that in such a case the maximum working load is often three or four times as great as the average, and if the engine has to be kept fired to take the maximum load at any moment the waste of fuel is very great.

Steam is slower in its action than electric or hydraulic power; but on the other hand, where initial cost is a prime consideration, a steam plant has the advantage. Local conditions must always determine which to use, although electricity is fast supplanting everything else on account of being so quickly applied and always ready for use, without being wasted when the machines are idle or partly idle.

THE FUNDAMENTAL PRINCIPLES OF WORKS ORGANIZATION AND MANAGEMENT.

By P. J. Darlington.

In this article and a second paper to follow next month, Mr. Darlington undertakes the very interesting task of reducing some of the greatest problems of works management to their fundamental elements. The maze of special methods and systems, employed in a multitude of shops, he believes can be separated, sorted, and classified so that the apparent confusion will prove to be but a mingling of a very few, simple, clearly defined and easily understood methods and systems. Each of these systems is then tersely explained, with a statement of the results it secures and the conditions under which it is best and those under which it fails. If the often mysterious subjects of stock keeping and cost keeping can be thus simplified into a scant dozen easily understood elements, Mr. Darlington believes that the manager can readily combine from them such organization, routine, process, or records as will best serve the purposes of his works, and may be certain in advance what he can expect his system to accomplish and what difficulty or cost will attend its use.—THE EDITORS.

ENTERPRISE, ingenuity and good judgment in matters commercial and technical are the real forces of successful manufacturing. The plan of organization and management, with its rules, routines, and records is merely mechanism for utilizing those forces.

This mechanism may fail either from lack of essential features, or from too great complication by dissipating effort in red-tape. We learn by experience that unnecessary complication discourages effort and invention and reduces quality and quantity of product. Our problem, therefore, is not to evolve an elaborate and logical system of organization and management, but rather to build the very simplest and most direct plan that will substantially meet our needs.

Manufacturing works differ widely in the character and variety of their product, the material used, and the labor and intellect employed. They differ likewise as to commercial circumstances and conditions. For example, one works may be producing under fixed conditions while another is choosing new lines of manufacture, for sale in close competition, where a knowledge of the normal cost of widely different articles is essential for guiding the growth of business into most profitable channels.

We therefore may not hope to find a ready-made plan of organization and management suited to our own conditions. Study of successful works may suggest new features and details, but usually not in

practical proportion for our needs. Our problem is similar to that of a designer who must produce a machine for specified work by applying his knowledge of elementary mechanical forces, movements, and materials. He adopts the fewest and simplest parts for minimum cost, internal friction and risk of breakdown.

The direct application of the simplest means available to each clearly defined purpose is the secret of building up a vigorous and sturdy organization and management. "System" beyond this is idle mechanism and a source of loss and risk. What must be accomplished can be determined only by those well acquainted with the business and conditions. They alone can define the needs and purposes in correct proportion of importance. There appears, however, to be no good reason for the present almost total lack of comparative data and discussion of the "means available," or what we may call "elements of organization and management."

The purpose of this article is to describe and discuss a few of these elements, in an effort to place the subject on a scientific basis so that organizations, routines, clerical processes, and records may be chosen for any given purpose with a fair knowledge of what they may be expected to accomplish and of the difficulties and costs of using them.

We put value into our manufacturing business for interest on investment, for operation and maintenance, for purchase of materials, and for employment of labor and intellect. We combine them into a product saleable at a profit over these constituent costs. This profit depends not only on cheap manufacture but also on wise choice of product to be made and marketed.

The operation of our business is divided and subdivided into such transactions or undertakings; for example, the addition of a new product, the investment in special tools for it, the setting of stock limits on parts, etc., even down to the choice of operations in its manufacture.

Our annual profits depend not only on the successful forwarding of each undertaking, but also on our increased experience from it and our improved judgment thereafter. Evidently organization and management must not only solve each problem and carry through each transaction, but also must make the experience available for the future. The sum total of such experience may become a large asset of the business, and is of no less actual value because it cannot be estimated in dollars.

With good organization and management each employee understands the purpose of his efforts. He gains respect for his own work

and that of his associates, and he enters into *esprit de corps* far more lasting and valuable than aimless enthusiasm.

Good organization and management considers human nature. Men of mechanical education and experience are not annoyed by clerical duties; every employee feels a normal share of responsibility and is at the same time confident that results will be appreciated at their true values; every man, from the inventor to the mechanic, is given the incentive and working data for the best individual effort and results as well as for the best co-operation of individuals and departments.

An organization and management based on accurate knowledge and results weeds out incompetent employees and increases the average efficiency of the working force. Clearly defined purposes and definite means allow each duty to sift down to the cheapest grade of intellect that can handle it, and give each employee an opportunity to study ahead of his position and advance to the limit of his capabilities.

With prompt and practical information in regard to orders, stock, men, and equipment we may balance our departments and operate our works at highest efficiency and maximum output without danger of overloading and breaking down some part of the industrial mechanism, thereby throwing the works into confusion and nonproductiveness. Accurate and comparative knowledge of costs enables us to develop the more profitable lines of manufacture and so increase the profit factor of our business ahead of less scientific competitors. In many ways good organization and management increases efficiency and adds annual profits not calculable in dollars.

These as well as more measurable benefits are very largely dependent upon our correct understanding and wise application of elementary principles which are capable of scientific study. A good understanding of human nature, a high sense of justice, and other personal good qualities lose most of their force in the confusion of a mismanaged industry where fact is smothered under form and noise mistaken for results. On the other hand, we must remember that clerical system is *not a prime force*. For example, if our product be unnecessarily complicated in design, or our stock scattered about without needed facilities for handling and storing it, clerical system will add to the trouble and may greatly reduce output.

Stock.

Fundamentally, stock may be classified as:—

1.—Accidental.

2.—Standard.

1.—Accidental stock is an accumulation of materials, parts, or products which it is not intended to continue to carry in stock. It may be extra parts which are normally made on an assembling order, or it may be unusual, special, worn, or superseded articles. That it has not gone to scrap implies a hope of using it. All that we can do is to advertise it to those departments that can suggest a use for it. To assure its receiving attention at the right time we record it in connection with the standard article on which it may be used, or for which it may be substituted, or we may cross-index it to several such.

When accidental stock is to be used in manufacture it must be clearly called for on the using order, with a statement of the standard stock, if any, for which it is to be substituted. This records its use, avoids duplication with new material, and prevents the using order receiving credit for labor not expended.

Accidental stock must not be confused with standard stock. There is no connection between them and they are very different in principle. There will be no further reference to accidental stock and hereafter stock will mean standard stock.

2.—Standard stock may be raw material, worked parts, or saleable product maintained in stock according to limits or on other authorized basis. When an article becomes standard stock it must, therefore, be made always as such on its own stock orders. Otherwise using orders would not get credit for all labor expended and the cost and stock records would be in error.

Our purpose is to fill orders promptly, cheaply, with lowest investment, and with least depreciation and loss from changing designs; also at least expense for handling and storing. When and on what limits to establish an article as standard stock is therefore determined in consideration of:

a. The nature, number and variety of its uses.

b. How far we can anticipate demand and how soon replenish stock.

c. The importance of large quantity in reducing cost and improving quality.

d. The amount of money invested in the stock and the value of the store space occupied.

e. Depreciation of the stock and possible lack of confidence in the stability of the design.

If a machine part is assembled into several different sizes or designs of product, at different times and on different orders, then by making that part standard stock and thus concentrating its manufac-

ture on one large order for a long-time supply, we may often gain enormously in cost, quality, shop capacity, investment, and clerical expense. Otherwise if the part be costly in material, special to that one product, and if it can be obtained in time to take its place in manufacture and assembling, then it may be better to make it on the general or assembling order for the machine. To establish such an article as standard stock might result in useless and expensive shop orders, stock transactions, records, investment, and cost for storage.

Evidently an article should be established in standard stock only with a clearly defined purpose and very definite gains in view. Divided orders for divided cost record are usually costly and useless as will be shown later. The cost office should serve manufacture, rather than the reverse.

When stock falls to the "low limit" an order is issued for either a "standard order" quantity or for a quantity to bring the total to a "high limit." The standard-order plan makes quantities uniform, costs comparable, and shortage evident. It is useful with bin stock systems, as described hereafter. The high-limit plan is more flexible to meet accumulated or extraordinary demand, and is therefore essential to the "order balance" stock systems. It may be modified by writing the orders to the nearest tens or hundreds to show shortages.

Stock limits are determined as the estimated demand for an assumed period of time. This demand and period may be recorded as a basis for adjusting limits to new conditions without a resolution of the entire stock problem for that article. If demand or design be uncertain the high limit may be omitted, thus assuring special consideration of and authority for each new order.

Stock Keeping.

We must have goods available when wanted and yet maintain economy of investment, storage, and handling with security against theft and loss. Reduced to elementary principles, stock-keeping systems are definable as:—

1.—Bin Stock.

- a. Bin View.
- b. Bin Record.
- c. Bin Record from Advance Tickets.
- d. Bin Record with Tickets Audited.

2.—Order Balance Stock.

1.—Bin-stock plans show the quantity of the article in the bin or rack. They take no account of quantities due to or from the bin on orders in progress. Therefore, they are applicable where demand is

frequent and supply quick, and especially where supply and demand are continuous, as in a works producing a small standard article in large quantity with one department making the part and another assembling it into the product. The bin is the reservoir between the making and using departments. By watching the rise and fall in the bin the supply is regulated to the demand.

1a. Bin View is a bin-stock plan in which the low limit is marked on the bin or rack and stock is kept up by observation and without records. It is applicable to articles that can be cheaply stored in plain view and are easier to identify and describe by sight than in writing; also to articles difficult or costly to measure, weigh, or count, and not worth stealing. In short, this plan is useful where demand is so frequent and for so many purposes, and the goods are so cheap, that any other system would cost, in clerical labor and delays to production, more than the results would be worth.

1b. Bin Record is a bin-stock plan in which the material stock and its movements are duplicated by clerical transactions. Every delivery to or from the bin is paralleled by a material ticket from the foreman to the stock keeper, and charged or credited to a bin record whose balance should be the quantity in the bin or rack.

The advantage of this plan is in concentrating the information and allowing stock to be more compactly and cheaply stored, out of sight, at a distance or divided among branch stock rooms, the bin record indexing the location of stock. In using this plan it is often a great help to designate each stock article by catalogue number, which reduces the writing and makes stock keeping more automatic.

In this plan there is usually not much safe-guard against loss or theft, as anyone can issue a ticket or raise the quantity on it.

1c. Bin Record from Advance Tickets is a bin-record plan in which the material tickets are limited to the quantities authorized by the material list of the shop order and are issued in advance from a clerical department to the foreman, filed on his desk behind guides, and surrendered by him to the stock keeper when the goods are delivered.

The tickets may thus be more cheaply and accurately made out, but they suggest to the stock keeper what the clerical department expects the goods to weigh or measure, and this reduces accuracy. There is not much safe-guard, as any department can raise the ticket to cover theft. The plan is inflexible and slow for partial delivery and in case of substituting a different material. It puts an extra clerical department ahead of shop production and in position to delay and reduce output.

This plan evidently requires that design, manufacture, and clerical work be very settled and stable; also that the business be large enough to keep a sufficient force to avoid delay to production from the absence of a small part of the clerical force.

1d. Bin Record with Tickets Audited:—With this plan when a shop order is complete its material tickets are sorted, totaled for each article, compared with the material list, and corrections made in the bin record. To identify a ticket with its entry in the bin record either both must be serially numbered or both must quote order and date. A discrepancy between bin and bin record is still not proof of theft or loss, for there may be many errors on uncompleted orders which cannot be checked up otherwise than by inventory and comparison with their material tickets—often a difficult task.

The following defects are evident in these bin-record plans.

First. Great clerical expense for tickets, entries, and comparisons.

Second. Possible delay and reduction of output from productive men and equipment waiting while tickets are being issued, goods weighed, and receipts exchanged.

Third. The many clerical errors, omissions, and losses that may be only a normal proportion of the very many scattered documents and entries.

Fourth. The costly investigations of and arguments over these old errors, etc.

Fifth. The very doubtful or long delayed discovery of loss or theft.

In the material list we have a checked and proven statement of materials needed for the shop order, condensed, classified, and convenient. It may not be wise to scatter these data about on hundreds of material tickets to be later collected, sorted, and tabulated for comparison with the original.

2.—Order Balance Stock Plan takes account of orders in progress. It shows the balance of the article in stock if all orders to make, buy, use and sell it were completed. It shows the balance in and due to bin less stock due from bin.

This plan is useful wherever stock goods must be ordered in advance of and on account of a known demand (such as for an assembling order). This includes nearly all general machine-making business, using stock materials or parts, and especially those building large machinery. This plan does not show what quantity is in a bin and it takes no account of actual deliveries across the counter between stock room and shop. It therefore does not require material tickets.

In an order register a page is assigned to each article and all orders to make, buy, use or sell it are registered as issued. In the column "To Stock" are entered quantities ordered to make or buy, and in the column "From Stock" are entered quantities ordered to ship or use. The third column is reserved for "Balance." As soon as a shipping or an assembling order is issued its material list is written up in the From Stock columns of the different articles. If any balance is brought below the low limit, a stock order is at once issued to make or purchase stock up to the high limit.

If we desire to carry a large stock of a certain finished product and only a small repair stock of a given part together with a little special material from which the part is made, this is accomplished by simply placing the high limit as low as we wish on the part and on its raw material. Shop orders will combine the small limits with the large immediate demands. With any bin-stock plan we would have carried large stock each of the product, the part, and the material, with an immense waste of investment and storage space.

To detect shortage (indicating theft or loss) it is necessary to count the quantity in the bin, add that due to the bin, and deduct that due from the bin. For this purpose the order register will give the numbers of the unclosed orders. Orders to ship, buy, or make the article will usually show quantities completed, and still due, but orders to use the article will not show this unless bin deliveries are recorded. Lacking such record the using orders in progress must be inventoried for the article in question. The best time for such a balancing is when a replenishing order is requested, for there will usually then be no orders in progress to buy or to make.

If the balance shows a discrepancy between the actual stock and the order register, we may investigate for theft or loss and make an entry in red ink "unaccounted for" in the proper column to balance the register with stock.

This order-balance plan furnishes the best clerical safe-guard against theft or loss, for all entries are opposite their order numbers, and are therefore, easily checked with their orders. Suppose that to cover theft the entry from stock had been raised in the order register; then under that same order number on another page, it could be seen that the assembled machines delivered were less than should result from the quantity of parts shown as used. Moreover, if the register shows considerable divergence from quantity ordered, either in the assembled machines delivered or in the parts used, an irregularity is indicated and scrap reports may be consulted to account for parts spoiled.

Orders cannot always be filled to exact quantities called for, on account of accidents. To maintain accuracy of the stock registers it may be desirable to enter the quantity in pencil when the order is issued, and to confirm or correct it in ink when the order is finished. This cannot be done on the orders to use unless a delivery record is kept, but these "from stock" entries may be cut down in proportion to the shortage of complete machines delivered. This keeps the books on the safe side and causes any loss to appear in the balance.

A copy of the material list may be used as delivery record between stock and shop. When so used it furnishes data for this correcting of quantities used and also for balancing order registers (instead of inventory). Such delivery record completes the order-balance plan, but is not essential to its practical success and is often very costly.

It will be noted that the order-balance plan is a record of the progress of the article from its purchase as raw material to its sale as part of a finished product. The article is safe-guarded from the moment it is paid for until it is billed to a customer, assuming, of course, the customary precautions to insure actual receipt of all that we pay for on both purchase and making orders. This safe-guard is of such nature that it is not considerably reduced by keeping the order registers in the stock room where they may be useful as an index to order numbers and stock location.

It is characteristic of this order-balance stock plan that the few cheap entries from orders as issued form the basis of a very practical safe-guard against wholesale or accumulating theft. The refinements are only for greater accuracy. A register of orders to make or buy an article is the "Reverse Arrangement" or index from article to order number and is usually found necessary for reference and record. The order-balance plan should not therefore be charged with the entire cost of the order registers.

Summary of Stock Plans.

The above covers all the elements of stock keeping. The bin plans and the order-balance plans are entirely different and for different purposes. Both may be applied to the same article. They may be combined on the same sheet. By adding two sets of vertical columns to the order register, a bin record may be kept thereon, tabulated to order number. This makes an absolutely complete and self-contained record, but often a very large document.

The user may choose the one or several of these stock plans best suited to his needs. For example, if his stock be made up of a few

valuable and many cheap articles, he may put brass and worked parts on the order-balance plan, and the remainder on the bin-view with orders to buy or to make registered. In practice it is usually found that the great majority of small, scattering transactions are in cheap steel and iron articles, such as bolts, screws, nuts, and bar steel, for which an order-balance plan would be relatively costly and comparatively unnecessary.

When product is serially numbered we may state on the assembling order the block of machine numbers assigned for use. In an order register we may immediately enter a brief description, the order number, and all the machine numbers (a line for each). As shipping orders are received we enter in pencil, opposite the machine, the shipping-order number and the name of the customer to whom it is assigned. At the time of shipment we enter the dates and confirm shipment in ink.

We may add a column showing date of receipt of each machine as it comes from the shop to the stock room.

It will be noted that this is merely a combination of order-balance and bin-record detailed to individual machine numbers. It shows the balance available as well as stock in hand. Its practical value is in the ease and certainty with which errors and loss can be traced and in its usefulness as a record of the manufacture and disposition of each numbered machine.

A thorough understanding of these stock plans will help to simplify stock management. Every plan described has its own profitable uses, but misunderstanding and misapplication of them have probably caused more loss of production and profit than any other form of mismanagement.

(To be continued.)

EDITORIAL COMMENT

The Cause of Good Roads.

THE creation of a State Department of Highways, as urged in a report of the Joint Committee of the Senate and Assembly of the State of New York, seems to be the best means yet proposed for effective and economical work in the improvement of the public roads. Of course, as in every similar case, everything depends upon the personnel of the department; but the conditions favor the selection of men of broad and sound views and the removal of their effort and undertakings from the most disturbing effects of frequent political change. Further, while the proposed "constructive legislation" establishing the department carefully preserves the principle of home rule in county and town affairs, a strong and sane policy consistently carried out on the State roads would have a powerful educational and moral influence upon the local officers and their work.

Neglect of the roads is one of our notorious economic sins in the United States, and preaching from the text of Continental example is of little power to work reform. The creation of a system of good State roads, penetrating and connecting the principal cities and villages, would establish everywhere a demonstration from experience of the enormous saving possible in haulage to and from the farm, and inevitably would result in the gradual extension of betterment in the work done and the result secured on market and town roads.

At present we are suffering from total want of any consistent policy, and almost universal prevalence of short-sighted local favoritism and jealousy. The commissioner "favors" his section of the town; the contractor "favors" his end of the district. Scarce one seems to realize that it is the road that must be traveled, not that immediately in front of his fence, that saves or wastes time, money, horseflesh and temper. Improvement miles away is no less important than improvement at the gate.

The need for this breadth of view is one great reason for committing the general management of the highway improvement fund to a non-partisan and a continuing commission, rather than to the change and chance of the State engineer's office—excellently filled now, perhaps less so after another election. And the movement is too important economically to be merged in the multitudinous detail of an already heavily burdened office. Mr. W. Pierrepont White, in an address recently delivered, aptly contrasted the possibilities of the highway system in New York State with those of the Erie Canal. In total volume and in breadth of distribution of benefits, the former is surely the greater.

Forest Preservation.

ANOTHER direction in which State administration must be extended and stimulated is that of forestry. We have often urged the point, and we are sincerely glad to see that so able an influence as that of our great engineering societies is active in the cause. A resolution lately adopted by the Board of Directors of the American Institute of Electrical Engineers declares that as "the value of water powers is determined in great measure by regularity of flow of streams, which regularity is seriously impaired by the removal of forest cover at the headwaters . . . this impairment frequently being permanent because of the impossibility of reforestation, owing to the destruction

of essential elements of the soil by fire and its loss by erosion . . . the attention of the National and State Governments should be called to the importance of taking such *immediate* action as may be necessary to protect the headwaters of important streams from deforestation and to secure . . . the introduction of scientific forestry and the elimination of forest fires . . ."

The italics are ours. It is not a remote danger, but a present and progressive damage with which we have to deal. The Ohio valley is having a bitter demonstration, and about the upper watersheds of the Delaware, the Hudson, and the Connecticut, destruction productive of like disaster is already under way. The difficulty of the problem, solvable only by State intervention, as we have already shown, is that the cutter of timber—or worse, of pulp wood or "acid" wood—feels no concern as to the aftermath; and those who do have no power of control and no (or but very remote) redress. The creation of Eastern forest reserves, as proposed in the Lever, Currier, Gallinger and Bradley bills, now in the House Committee on Agriculture, would do much; but beyond this Federal legislation and protection there would seem to be crying need for a strong State forest law which would prohibit and prevent the absolute denudation now carried on, and enforce the preservation of sufficient cover, if not actually provide for reforestation. It would beyond doubt soon prove its wisdom and its interest even for those now engaged solely in destruction and removal; but this education apparently must be at first compulsory. May it not be long delayed!

The Safeguarding of Workmen.

IT gives us much pleasure to afford space for the following notice, issued by the American Institute of Social Service.

The movement looking to the reduction of waste of life and limb in industrial occupations has always received our strong sympathy, and in furtherance of it THE ENGINEERING MAGAZINE some time since secured from M. Jacques Boyer two articles exhibiting the latest advance in this effort in France, where both manufacturers and legislators offer many models for valuable study. One of these papers will deal with the museum of the Conservatoire des Arts et Métiers at Paris, where the latest safety devices and ideas in industrial hygiene are assembled, and the other will be concerned with Continental practice in the promotion of safety in mining. Their appearance will be happily coincident with the exposition. The announcement is as follows:—

"An Exposition of two months will be held early in April in New York, under the auspices of the American Museum of Safety Devices and Industrial Hygiene, for showing the best methods of safeguarding workmen and protecting the general public. The exhibits will consist of safety devices, protected machinery in actual operation, models and photographs. During the Exposition, illustrated lectures by engineers will explain industrial conditions and hazardous occupations and the most approved methods of safety.

"Believing that many accidents are preventable and to stimulate further invention, three solid gold medals are offered for the best safety devices in the field of transportation, mining, motor vehicles and motor boats. Two prizes of $100 each, one for the best essay on The Economic Waste due to Accidents, the other on The Economic Waste due to Occupational Diseases, are offered.

"The Chairman of the Committee of Direction is Charles Kirchhoff, and of the Committee of Exhibits, Prof. F. R. Hutton. There will be no charge for space. All inquiries and applications for space should be made to Dr. W. H. Tolman, at the Museum, 231 West 39th St., New York City."

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

TECHNICAL EDUCATION AND INDUSTRY.

A PLEA FOR THE RECOGNITION OF COMMERCIAL LIMITATIONS AND INDUSTRIAL ENGINEERING IN ENGINEERING SCHOOLS.

Charles B. Going—The Columbia University Quarterly.

THE discussion which centers about the defects and improvement of methods of technical education is a most complicated one. It is generally admitted that defects exist and that improvements are necessary, but there is no settled agreement as to what the defects really are and the possibility of improvement is precluded by this uncertainty. It would seem that the only firm foundation, on which those earnest workers who have the interests of technical education at heart can base their labors for improvement, lies in the oft-repeated assertion that the technical graduate must be trained for some time in practical work before he can be trusted to work out results which will be economically valuable. On this premise, Mr. Charles B. Going, in *The Columbia University Quarterly* for December, 1907, makes an interesting and thoughtful plea for the recognition in technical courses of the economic aspects of engineering.

The inherent tendency of all human systems is to crystallize and the history of thought in every domain has been a recurrent cycle of hardening creeds broken through from time to time by an outpouring of protesting revolution. The rise of the schools of applied science in the last century was itself a revolution in existing educational ideals. The schools have done a splendid work in the development of engineering, but they in their turn are growing academic and away from the close parallel with life which made their past achievements possible. The prevalent belief that the technical graduate is of little value for at least two years after graduation indicates that his training has failed to include recognition of some important elements in the problems he is supposed to have been taught to solve; in other words, that the subjects of his engineering course are not taught as they must be practiced. The cause of this defect is the fear of commercialism which has always haunted the university. In engineering anything within the laws of nature is feasible, but whether it is advisable is a question of dividends. In engineering projects the dividing line between commercial success and failure is usually narrow and the engineer whose function it is to carry works of construction or production to practical success must be able clearly to recognize the point at which technical refinement ceases to be economical. The fault of the engineering school is that they give their graduates too academic a devotion to the ideal of technical perfection and an inadequate idea of the imperative character of commercial laws.

"It is not for a moment desirable that the vision of the goal set by pure science be obscured, but only that the understanding be increased of the approximations which it is expedient to accept in actual performance, and the conditions by which they are determined. For illustration: the development of the steam engine from Savery's 'Miner's friend' to the modern Corliss, or

(say) the engines of the Inchmarlo, is a wonderful exhibition of improvement in efficiency in which the data of thermodynamics have been the inspiring and directing influence. Everyone must wish the student of mechanical engineering to possess sufficient knowledge of the science to understand what has been done and to take an intelligent part, if necessary, in continuing it. But the choice of power plant in any given case depends on a careful comparison of the net total of interest on investment, expense of maintenance, depreciation, wages of skilled attendance, and fuel costs. It may easily prove that—in a Pennsylvania coal mine, for example—a plain slide-valve machine, wasteful of coal but cheap and easily run, will be most serviceable to its owners. The average graduate is many times more likely to meet the need of advising as to such an installation than he is to find opportunity for further betterments in steam-engine design; but is he one-fourth as well-informed in the conditions of *commercial* efficiency as he is in thermodynamics?

"Or again: the design of a piece of machinery may require a sound, scientific knowledge of mechanics and kinematics, a careful mathematical calculation of stresses and weights, and a high degree of skill at the drawing board. But if cost of construction is important—and it usually is very essential—it requires also attention to economy in the use of the material and especially of the labor involved in manufacture; the selection of stock sizes; the standardization of gears, arbors, bores, tapers, bolts and screws; avoidance of difficult problems in pattern making and moulding, and minimization of labor in machining and assembling of parts. Does the average course impress the student with these common-sense considerations in the handling of materials as strongly as it does with theoretical mechanics or the technique of draftsmanship? Can it possibly do so, until the economics of engineering are given an entity in the curriculum, and made to occupy an arc of the educational horizon as large as that which they will find in the graduate's discovery of his life work?

"More curious, however, than this incomplete recognition of the industrial element in the generally accepted engineering courses is the absence of any adequate attempt to supply systematic training for the newest of the engineering occupations—manufacturing. This is the great exception, already referred to, in the sufficiency of the technical school to follow the specializations of modern applied science. The factory is surely no less characteristic and no less fertile a department of the industrial era than the railroad or the steamship. It employs, probably, a larger number of technical graduates than stationary, locomotive, or marine engineering, and the proportion is increasing. But while institutions so conservative even as the Lords of the Admiralty and the Navy Department have realized that the modern warship is a huge, coherent and interlocking, sea-going and power-driven fighting machine, and that it must be officered by engineers trained in seamanship and navigation, steam engineering and hydraulics, electricity, ordnance, sanitation, discipline, language and international law, our technical faculties seem to have been less responsive in their sphere. The civil engineering college has been very slow to recognize the factory as a vast, coordinated manufacturing machine, demanding a personnel instructed not merely in dynamic engineering, but in executive organization and management, economical works design and construction, transportation and handling appliances, tool-room practice, stores-keeping, wage systems, time records, shop discipline and sanitation, and by no means least, cost analysis and study. Hardly a course has been founded by any technical school which will ground the student thoroughly in this concept—that the manufacturing plant is, or should be, a harmoniously coordinated if intricate device, in which, by skilled organization, the factors of power, machinery, and labor are made to cooperate in the manipulation of material, so as to use the priceless and irreplaceable element of *time* for the maximum of production with the minimum of expenditure or depreciation in any part. It has remained, so far, largely for outsiders to preach this new doctrine of the times. It is not surprising that a new profession should arise outside of the schools; many of us can remember when all the instruction given in electricity was a part of the physics course. But while electrical engi-

neering was promptly adopted and has grown to be one of the noblest children of its *alma mater,* industrial engineering still stands unacknowledged on the doorstep knocking vainly for admission. . . . . .

"I have been tempted to expand this point of current criticism upon the technical curriculum because just here the difference is most discernible between the preparation which the school gives and the equipment which the work of the graduate demands. The difference is not so much quantitative as qualitative. For if in theoretical training the courses of instruction lean too as qualitative. For if in theoretical training they lean too far toward the handicrafts. The aim (to illustrate by an intentional exaggeration) seems to be to turn out a composite of the natural philosopher and the mechanic—a sort of scientist in overalls. Now it is not manual training, however glorified, that is needed, but a trained observation of, and a capacity to measure, the forces and factors entering into production or construction, under competitive commercial conditions.

"Practicing the future mechanical superintendent in chipping and filing, or setting him at elementary work on the planer or the lathe, is about as fruitful of good results as teaching an architect to lay brick or a mining engineer to slog a drill. At best, with the hours available in a four-years' course, he can scarcely acquire the dexterity of a junior apprentice. What he needs to know is *not* how to do filing and fitting, but how to avoid them so far as possible, as enormously wasteful and expensive processes which the genius of modern manufacturing endeavors to the utmost to eliminate. . . . . .

"With much diffidence, and some trepidation, the suggestion is advanced that (without any change in the full courses laid out for the specializing student) the general educational scheme might be brought nearer to the plane of practical professional work —nearer to the life the graduate must follow—if a more careful scheme of minor courses not *elemental,* but *fundamental,* were worked out, proportioning more usefully the *Nebensachen* to the *Hauptsache* for the candidate for any given degree, and thus affording room for the desirable larger number of these coordinate studies.

"Esoteric knowledge is demanded only of the adept. The technical graduate ordinarily does not need to head a rivet with the skill of an expert boilermaker; neither does he need the mathematics of an astronomer. Profound acquaintance with electro-physics probably will never be exacted of him (after his examination for his degree), but he ought to be amply qualified to select proper equipment for a lighting station, or to dissect the representations of an impetuous salesman of dynamos. He might even design an excellent steam plant while he still remained a little vague on the subject of entropy; and he might direct and check the work of draftsmen who have many times his manipulative skill (and command a fraction only of his salary), though his own lettering be far inferior to copper-plate.

"Superficial? No; he may be absolutely thorough in everything, so far as he goes; and except in his specialty (in which the technical student must go very far indeed) thoroughness of training as a whole depends quite as much upon amplitude as upon altitude. If the industrial effort works a little too close to the ground, the academic tendency is a little too urgent toward the empyrean; but with closer cooperation their resultant might be the definition of a body of education of ideal proportions. We need, especially in our schools of applied science, a closer fellowship between town and gown. The jealousy of many universities, which discourages the teacher from maintaining close touch with active professional work, is one of the regrettable influences forcing our practical science courses out of parallel with the progress of industry. A more weighty one still, perhaps, is the small opportunity given the alumnus to be heard in university councils and to bring back within university bounds the fresh spirit and suggestion of the constantly changing world without. The result is an inevitable set toward formalism and scholasticism on one side, and toward apathy on the other. Through freer, wider, and more frequent intercourse between faculty and alumni, probably more effectually than in any other way, will the creative forces of the system of technical education be kept fresh, vigorous, and instantly responsive to the demands of industrial life."

FLOATING DRY DOCKS.

A DESCRIPTION OF THE VARIOUS STRUCTURAL TYPES OF THE FLOATING DRY DOCK AND ITS ADVANTAGES OVER THE STATIONARY DOCK.

Harry R. Jarvis—North-East Coast Institution of Engineers and Shipbuilders.

THE rapid development of naval engineering and marine transport has presented to the civil engineer many problems of ever increasing magnitude in connection with the building and extension of harbor works. One of the most important of these is the provision of adequate dry-docking facilities and in this field the introduction of the floating dock is the most interesting development. Recently floating docks were made the subject of an interesting paper by Mr. Harry R. Jarvis before the North-East Coast Institution of Engineers and Shipbuilders. The following extracts from this discussion outline the main structural features of the types now in use and the advantages of the floating over the stationary dock.

"It will be as well, before proceeding with a description, to classify the various types of floating docks. It has been found convenient to designate various types of non-'selfdocking' and 'selfdocking' floating docks as follows:—The 'box' type of floating dock is non-selfdocking. The 'selfdocking' types include the 'depositing,' 'offshore,' 'sectional' pontoon, 'Havana,' and 'bolted sectional' docks.

"The non-selfdocking 'box' dock, which does not need any elaborate description, consists simply of a pontoon with two side walls forming one homogeneous whole. Being solidly built, this type is naturally the strongest form of floating dock which can be constructed. Whether 'selfdocking' facilities in a floating dock are absolutely essential depends entirely upon its situation. It is generally found that marine growths, which are so detrimental to a ship on account of loss of speed, do not in any way interfere with the life of a floating dock, but rather tend to preserve the material. This statement is not based on theory but on actual experience over many years. It is not, however, the portion of the dock always entirely submerged which suffers most from corrosion but that portion between wind and water, about the normal waterline of the dock, which constantly varies with the amount of freeboard given to the floor of the pontoon. This part is very easy of access when the dock is not in use, for by pumping out the water and heeling the dock sideways or endways, it is always possible to clean and paint that portion as often as may be found convenient. Naturally, this operation is not so satisfactory as selfdocking the dock in a proper manner.

"To enable the underwater parts of a floating dock to be examined, cleaned, painted, and if necessary renewed, with perfect safety and expedition, there was designed for the Russian Government in 1877 a single-sided outrigger dock which was designated a 'depositing' dock. This dock which, in end elevation, is shaped like the letter L, is of peculiar construction, has a single side wall which contains the pumping machinery, and the pontoon is made up of a series of 'fingers' with spaces between them. The necessary stability to enable the pontoon to be lowered and raised is obtained by an outrigger which is connected to the side wall of the dock by a series of parallel booms hinged at each end. As the wall of the dock is divided into two equal lengths, it will be readily seen that to selfdock either portion of the dock it is merely necessary to separate the two halves and disconnect the booms from the portion to be dealt with; the remaining portion of the dock may then be docked in the usual manner. This type of dock can not only dock vessels but, owing to the peculiar construction of the pontoons, is enabled to 'deposit' them on a grid, formed by groups of piles. It is obvious, therefore, that in certain situations, such as non-tidal harbors or rivers, comparatively cheap docking accommodation need only be limited by the number of grids provided.

"The 'off-shore' dock, which was designed and patented in 1884, is a modification of the 'depositing' dock. The pontoon is continuous and L-shaped in end view. Unlike the 'depositing' dock, however, the 'off-shore' dock is, as its name implies, attached to a series of shore girders or tri-

angulations, by parallel booms, hinged at each extremity. The inner end of the top boom is not rigidly attached to the shore girder, but is suspended on a crank which allows the dock to take a small inclination in either direction. This movement is indicated in a simple manner to the man in charge of the dock, and enables him to correct, by manipulation of the valves, any tendency of the dock to go out of trim, and so avoid any undue strains on the shore girders or other parts of the structure. The 'off-shore' dock is very simple in construction and is easily handled. It can be very profitably employed in suitable situations. When submerged to receive a vessel it is merely necessary to sheer the latter in sideways, or the vessel can enter the dock from either end. It is then rapidly centred by telescopic mechanical side shores. When properly centred the vessel is lifted in the usual way, and, without stopping the pumps, it is supported by mechanical bilge shores, which consist of strong timber booms hinged at their inner ends to the pontoon dock, and supported at their outer ends by a cast steel rack, which is raised or lowered by worm and pinion gear, driven by suitable gearing from the deck of the side wall. The sound of a hammer need never be heard when docking a ship on an 'off-shore' dock. Many examples of this type of dock have been constructed, all of which have given the greatest satisfaction.

"The 'sectional' pontoon dock is made up of a number of separate tanks or pontoons, which are held together by two side walls. This type is very suitable for vessels of medium dimensions, and owing to its form can be very easily constructed in places where a dock of any other description would be practically impossible to complete. The separate sections of the pontoon can be easily erected and launched, after which the walls can be erected in place.

"The 'Havana' type of floating dock consists of two continuous side walls, between which are attached three or more (usually three) separate pontoons, two end sections and a central section. At intervals along the walls two tiers of lugs project from the face of the wall; corresponding lugs are built on to the side of the pontoons, the lower set of lugs being just above the light waterline and the top set in line with the top of the pontoon. The actual joint between the pontoon and wall is made by pairs of fishplates, secured by large tapered screw bolts. Several examples of this type of dock have been constructed during recent years, but although the 'Havana' type is a very strong and useful form of dock, the latest and undoubtedly the best and strongest form of selfdocking floating dock is that known as the 'bolted sectional' type, two examples of which have lately been constructed, and a third, destined to be towed to Callao in Peru, is now in an advanced stage of construction at Wallsend.

"The 'bolted sectional' dock is, generally speaking, a modified form of 'box' dock, having the longitudinal strength of the latter combined with the selfdocking facilities of the former. This type is built in three sections of approximately equal lengths, the two end sections being symmetrical. The ends of the walls are stepped down, the lower step forming a docking land, when selfdocking the centre section. The joint between the three sections is usually a combination of butting angles bolted together for the underwater portion, and butt straps for the remainder. The end bulkheads of the various sections of the dock occur about two feet from the section ends. It therefore follows that when the sections are brought into position for coupling up, a chamber about four feet long is formed, from which the water may be removed and so allow the bolts in the joint angles across the bottom and up the outer sides of the pontoon to be inserted. The ends of the centre section are recessed, and a compressible compound inserted to enable a tight joint to be made, so that the water may be removed from the joint chamber when making or breaking the connection between sections.

"With regard to the facilities for selfdocking possessed by the various types of floating docks as enumerated and described, the 'bolted sectional,' from actual experience, is as simple as any of the other, excepting, perhaps, the 'off-shore.' The 'Havana' type certainly calls for very careful manipulation to enable all the tapered bolts to be withdrawn, and, moreover, the dock has to be heeled over sideways twice in each direction when selfdocking the centre

section, or the two end sections, which are usually taken together. In the 'sectional' type of dock, the pontoons are easily self-docked. The bolts connecting the bottom flanges of the walls to the pontoon having been removed, water is let into the section to be selfdocked, to overcome its surplus buoyancy; it is then removed, the remainder of the dock sunk to the necessary draught and the free section docked between the walls, in the usual manner. However, as long as proper precautions are taken to preserve the interior of the dock and the outer shell above light waterline by suitable protective composition, there is no necessity to selfdock at more frequent intervals than, say, from 10 to 15 years."

There is no class of repair work which cannot be satisfactorily completed on a floating dock. Extensive bottom repairs and important ship lengthening contracts have been expeditiously carried out. It is especially useful in the case of vessels which require to be sighted after grounding, as the docking and undocking is frequently accomplished in well under three hours. For cleaning and painting the floating dock is pre-eminent. The free circulation of the air during painting is of immense advantage.

Ease and rapidity of construction are important points to the advantage of the floating dock. There are numerous examples of very rapid and satisfactory construction in cases where time was of importance in providing docking facilities for specific purposes. The "Havana" dock, with a lifting capacity of 10,000 tons, was built, launched and towed a distance of 6,500 miles in a little under eleven months and was ready for immediate service on arrival at Havana. This performance also illustrates the mobility of the floating dock which is another of its great advantages. The transport of the Havana dock is only illustrates the mobility of the floating dock, have been towed long distances with perfect safety and success.

THE DESIGN OF STEAM-ELECTRIC POWER PLANTS.

THE BEARING OF THE MANAGEMENT AND EFFICIENCY OF THE DESIGNING DEPARTMENT ON FIRST COST AND ECONOMY OF OPERATION.

Frank Koester—Electrical Review.

IN the design of power plants the aim is to secure the highest economy and efficiency of operation compatible with reasonably low first cost. While careful superintendence is necessary to get the most out of a plant, the possibility of securing thoroughly satisfactory operation depends primarily on the ability of the designer and his staff. The following abstract of an article by Mr. Frank Koester in the *Electrical Review* for January 18, 1908, takes up a novel aspect of power-plant design, namely, the management and efficiency of the designing department and their bearing on first cost and economy of operation of the finished plant.

In the design of steam-electric power plants, "the designer is frequently in the employ of the company; contracts are sometimes made with a firm of consulting and contracting engineers to furnish the plan only, or in some instances the entire plant for a fixed sum. Sometimes a contract is made between capitalist and contracting engineer under which the latter is paid for the design and erection of the plant by a fixed percentage of the total actual cost of the plant. Another method is to pay the consulting engineer, for his services in designing and supervising the erection of the plant, a fixed fee plus a percentage on the total cost of the plant."

In the first case the first cost is not likely to be excessive but the capitalist runs the risk that his designer may fall very far short of economy and efficiency of operation unless his experience is known to have lain along the lines of power-plant design. In the second case efficiency of operation is usually attained on account of the wide experience of the designer but there is a tendency for him to raise the first cost as much as possible in order to swell his own profit. The third form of contract is perhaps the most satisfactory as the percentage is necessarily small and the designer has no very great incentive to increase the first cost.

In letting contracts for the design and construction of power plants the capitalist should not only investigate the financial standing and business reputation of the contractor, but should satisfy himself of the ability of the contractor's designing staff and particularly of the designer in charge. This is especially true in the case of those contracting firms who for one reason or another make frequent changes in their staff. Changes in the designing staff, particularly of the chief designer or his principal assistants, are likely both to increase the first cost of the plant and to interfere seriously with the securing of efficient operation. Primarily the satisfactory operation of the plant depends upon the designer, and as this fact is more and more recognized it may be expected that guarantees of plant efficiency will be required of contractors in the same way that manufacturers are required to guarantee the efficiency of individual machines.

"As the scope of power-plant design is broad, embodying mechanical, electrical, structural, architectural and often civil engineering work, it is necessary, particularly in the design of large plants, to employ able assistant designers and draftsmen in each of these branches.

"For instance, in designing a plant of 25,000-kilowatt capacity the staff may consist of the chief, one assistant (all-around man), who is familiar with the various branches of engineering required in connection with the plant, and four draftsmen (assistant designers), who are experienced in the four branches previously mentioned. The mechanical designer, who is always most familiar with the operation of steam-power plants, should arrange the general scheme and particularly the system of piping, as well as all foundations for machinery. The electrical designer, of course, will handle the wiring and switchboard equipment, and the structural man will have charge of the design of the structural work of the building, as well as such structural steel work as is necessary for supporting coal-handling machinery, boilers, etc. The architect is not usually called upon, as is evident from the character of many power plants, the architectural features having been sadly neglected. In plants of smaller capacity, the employment of a special architect is not justified, but an architect also qualified as a civil engineer might be employed to handle the architectural features and others, such as retaining walls, condenser-water tunnels, etc.

"In order to bring about economy in the drawing room, for the less important work, such as tracing, lettering, etc., a few tracers must be employed, who may be shifted from one branch to another as necessity requires.

"While checkers are necessary for every branch of designing, it is not feasible to employ one for each branch. It is customary, however, in the structural steel branch, to have a special checker in connection with the design of very large plants. In the design of such plants where the employment of a special checker for each branch is not warranted, the checking should be done by turning over the drawings to one of the other assistant designers, who will check it in conjunction with the original draftsman. This applies purely to the checking of dimensions, etc., as the work of designing has been carried on under the supervision of the principal designer and the all-around man. Any attempt to make it a part of the checker's duty to check the design would be a repetition of work, and the checker employed may not be competent to check the designs pertaining to each and every branch. It will, therefore, be seen that the employment of a general checker for checking the dimensions and the designs pertaining to all branches would not be justifiable, and a man with such general knowledge, including also thorough knowledge of every detail of the design, construction and operation of the plant, could not be found, because engineering, which now covers such an extensive field, has become highly specialized. To employ designers and able draftsmen for each individual branch, for a small, or even medium-sized plant, can not always be done, as the item of engineering expense would be too high in proportion to the cost of the plant. As the character of work done by a firm of consulting engineers covers not only power-plant design, but also general engineering work, and the chief designer frequently is not an expert in the particular work of power-plant design, an all-around power-

plant engineer is required, to act in a supervising capacity in connection with these various branches, whose duty may also consist in checking all drawings which pertain to the general design. Having employed an all around designer in this capacity the lower grade of draftsmen may be shifted from one line of work to another, thus not only cutting down the running expenses of the department, but also training these draftsmen for the duties of a general power-plant designer.

"When capable draftsmen or assistant designers have an idea or scheme in connection with the work in their particular line, they should be encouraged in developing it and should not, as is too often the case, be overruled by the chief simply because he, as the head, has the mistaken idea that all good suggestions should emanate from him. If these subordinates receive such encouragement the efficiency of the department will be materially increased, and, naturally, the running expenses of the department will be accordingly decreased. Furthermore, if such ideas or schemes are good this may be seen at a glance by a capable chief, and the subordinate should be given an opportunity to develop them, which usually will not absorb much time, because of the interest which he takes in them. Credit should also be given the subordinates for such ideas, which should not be appropriated by the chief and put forth as his own scheme, nor should the chief throw the blame for all bad features of his own schemes upon his subordinates. This is one of the principal reasons why rising designers do not stick to the drawing-board, but seek opportunities elsewhere, and as a consequence, capable draftsmen and designers are scarce, such men devoting their energies to other branches where greater rewards are in store for them. For this very reason some of the universities discourage the students in the pursuit of occupation at the drawing-board.

"With proper management on the part of the executive head of the firm the conditions described would not exist in connection with its staff of engineers and assistants; and capitalists should be most careful in the selection of a firm of consulting engineers which is to take charge of their work, that such executive heads, and others concerned in the business management, have been chosen with proper regard to their ability to select and control the engineering staff, and that such managers do not owe their preferment to favoritism."

STATE CONTROL OF ELECTRICITY SUPPLY IN GERMANY.

A DISCUSSION OF THE RECENT PROPOSAL FOR THE NATIONALIZATION OF ALL ELECTRICITY-SUPPLY UNDERTAKINGS.

Engineering.

THE proposal that the State should take over all the electricity-supply undertakings in Germany as a means of augmenting the Imperial revenues has not been taken very seriously by the technical press, but from latest reports it seems that the proposal was serious in intent and is likely to be brought up for legislative action. The effects of such State control of electricity supply were discussed in an interesting editorial in *Engineering* for January 10, which we reprint in full.

"Considerable stir has been created in Germany by the statement that the Imperial Treasury contemplated making the supply of electricity an imperial monopoly. When the news was first launched some weeks ago, people refused to credit what was apparently merely a rumor born out of the alarm over the serious state of the imperial finances. But the statement has been repeated; certain members of the Reichstag have declared that they regard the suggestion without any antipathy, and some newspapers and journals have discussed the proposal with an astonishing *naïveté*, as if the taxation of electricity could in a few years relieve the treasurer of all his troubles, without detriment to other interested parties. Nothing is definitely known as to the intention of the Government; but it is believed that the supply of electricity is to be made a monopoly, while the manufacture of electric machinery and apparatus is to be left free to industrial enterprise. The Continent is more accustomed to Government

monopolies than we are, and the unsatisfactory state of the German Imperial finances, which have steadily deteriorated of late, may be thought to demand a drastic cure. We cannot help feeling that the Bundesrat—the Government delegates of the different States constituting the German Empire—would do well, if not definitely committed, to prevent serious disturbance of the prosperous German electric industry by such alarming rumors. The Bundesrat will have to approve of any such bill before it can be placed before the Reichstag.

"Broadly speaking, the expenditure of the German Empire, as distinct from the expenditures of the States, is covered by the indirect taxes—the Customs dues—a certain surplus of which flows back into the treasury of the respective States—and stamp duties. Some articles of consumption—spirits, beer, tobacco, sugar, and salt—are also taxed in the imperial interest. The direct taxes go to the States, the rates to the communities. If the electricity supply is to become an imperial monopoly, the municipalities will suffer. The public electric power stations are either owned and managed by the municipalities, or they will become their property at the expiration of the concessions granted to companies. Most of these electric-supply undertakings are doing well; a smaller number do not pay their way, and would hardly be more prosperous under Government administration, which does not, as a rule, work more economically and successfully than private enterprise. If the empire is to buy these undertakings out, it will saddle itself with a heavy debt, and the municipalities will have to impose further rates to compensate themselves for the loss of revenue when they are no longer able to trade in electric light and power. That the State would succeed in increasing its income by raising the rates for the electricity supply is not at all probable, though it has been suggested. If the electric light ress made by gas illumination and gas light of twenty years ago, electricity might disregard its competitors. But it is too often forgotten that, astounding as the development of electricity has been, the progress made by gas illumination and gas power supply is still more astounding, and that the gas progress-curves continue to rise more steeply than the electricity curves. Any attempt to raise the electricity rates would benefit the gas industry and cripple the electric industry.

"In addition to the public electricity plants, Germany has a considerable number of private electricity works. We need not trouble about the small, strictly private installations. The industrial electricity works, which are private only in so far as they do not sell electricity, but generate it for their own use, can, however, not be dismissed as they have been by some journals. Those writers who placidly suggest that it cannot much matter to big works whether they generate their own electricity or take it from the State, betray an amazing ignorance. Twenty years ago it would have been possible without great risk to pass such a law. The State supply of electricity might then have turned out as economic and as rational as the network of streets and tramways of a newly-planned city. At the present time it is as reasonable to prescribe to the owners of works where to take their power from, as it would be to dictate to them where to buy their raw materials. Huge industrial establishments, metallurgical and chemical plants, mines, mills, etc., are absolutely dependent upon electricity. They generate their own electricity because they find it profitable. Whether steam, gas, pneumatic, or hydraulic power is to be adopted for a particular purpose is a question as to which opinions may change as the plant is extended. Central electric power-stations have certainly proved a success in some districts, but they cannot answer everywhere; and if the engineer is today to be commanded that he must buy his electricity of the State, he may to-morrow be dictated that he must obtain his coal, steam, and gas from the State. If he is not satisfied with the electricity and the steam, he may appeal to Parliament, where he is not likely to obtain much satisfaction.

"The whole idea seems to us totally unsound. All the troubles and quarrels that are now fought out in the town councils would become national parliamentary questions, and the legislative machinery still more clumsy, and it is difficult to see how the scheme can benefit the Imperial Treasury without at the same time impoverishing municipalities and industrials. The majority of the German electricians may, how-

ever, regard the threatened change with equanimity. We hear complaints over here that a few high officials are, as a rule, overpaid, while the staff are underpaid. These complaints are much louder in Germany, where we find in the big electric and other works large numbers of academically-trained and probably competent engineers working for poor pay, without hope of promotion. These engineers might welcome a State monopoly. They would become civil servants, entitled to a pension, with an increased certainty of tenure of office, and an easier time probably.

"We should be sorry to interfere in a German political question. We are only concerned with the general features of the matter. We have State monopolies in the postal and telegraph services, and we do not wish to abolish these monopolies. In federal Germany the railways are practically a Government monopoly, and the United States may adopt that policy. We do not want more centralization than is absolutely necessary in Great Britain, as we are not citizens of a Federation of States, and we are not in favor of monopolies on the whole. Yet we can understand those whom the fear of the abuses of trusts converts into believers in State monopolies, although they see in private enterprise better guarantees of healthy and steady progress. The electric railways would naturally fall under State control in a country of State railways. But the supply of light and power are local problems, and we cannot see how they can be improved by being made the object of a State monopoly."

THE CARELESSNESS OF WORKMEN.

A DISCUSSION OF THE LOSSES OF LIFE AND PROPERTY DUE TO THE GROSS CARELESSNESS OF THE AMERICAN WORKMAN AND THEIR BEARING ON EMPLOYERS' LIABILITY.

Thomas D. West—Philadelphia Foundrymen's Association.

SINCE its inception THE ENGINEERING MAGAZINE has always been one of the strongest supporters of that phase of the industrial betterment movement which has to do with safeguarding the workman from accident. In its pages many writers of prominence have shown that it is not only common humanity but sound economy for an employer to use every means in his power to secure his employees against the manifold dangers to life and limb that are the accompaniment of modern industrial conditions. In the following review, however, is presented an element in the question which is new to the pages of this magazine, but which has a profound bearing not only on the special case of safety in manufacturing pursuits but also on the wider problem of security in all fields of industrial activity and the employer's liability in case of accident. This is the carelessness of the typical American workman, the effects of which were discussed in a paper recently read by Mr. Thomas D. West before the Philadelphia Foundrymen's Association, and reprinted in *The Iron Age* for January 9, 1908, from which the following extracts are taken.

Mr. West first notes the popular habit of placing all the blame for accidents upon the employer and the demand for an Employers' Liability law which shall make the employer legally responsible for every accident regardless of its real cause, and points to the ill-advised proposals of President Roosevelt in his Jamestown speech and his recent message to Congress, and to articles in the popular magazines, as prominent examples of the popular ignorance as to actual conditions. "It is right and just to hold an employer responsible when he does not provide the best safeguards to life and limb that can practically be devised, but unless we enact laws that provide for fining and imprisoning a person for carelessness, we will never be guaranteed the protection that can and should exist to decrease greatly our loss of life and property through this cause. What can be conducted in Europe as to the liability of employers cannot be done as justly in America.

"It is safe to say that where there is one casualty in Europe caused by the downright carelessness of the employees, there are nearly half a dozen in America. Why? Simply because the American employee is

less careful, more flippant and indifferent to his duties. In fact, as an example, if in a railroad crew or a shop's gang, one of their number exhibits any great interest in being careful or economical, he is generally derided and in time often expelled from among them, and made to seek another situation. The 'don't-care' spirit is so prevalent in America that the foreigner, who at the start exhibits much seriousness in aiming to be careful, is in a short time often worse than the native, for the reason that many know no bounds when they discover the flippancy that is tolerated and so often common to many workers, a defect that is imbibed in their youth, chiefly through the American spirit of independence, buoyancy and pleasure seeking, which tends to create a nation of 'don't cares' and 'sports' instead of earnest, careful workers. In passing, it is to be said that the qualities generating carelessness in workers are more pronounced in prosperous than dull times, which accounts for the increase of casualties in the past five years."

To prove his contention that the American workman is much more careless than the European, Mr. West instances the comparative records of the United States and European countries in railroad and coal-mining accidents. In the former case, out of each 100,000,000 passengers carried on the railroads of the United States during the years 1901-1905, 31.64 were killed and 72.23 injured, against 1.27 and 4.88 respectively in the United Kingdom; while the number of coal-mining fatalities in the United States is three times as great per 1,000 men employed as in most of the coal-producing countries of Europe. Mr. West considers this unsatisfactory showing to be due to no other cause than the recklessness and gross carelessness of the American temperament. And the effects of this carelessness are not confined to the destruction of life but are almost equally to be deplored in connection with wholesale waste and destruction of property. A striking example of this is the fact that the loss in New York City by fires having their origin in the careless throwing away of burning matches and cigarettes amounts to $2,500,000 annually, or on the same basis, about $50,000,000 for the whole of the United States.

"Considering the subject of losses by manufacturers through carelessness, it is safe to figure that breakage and other losses caused by operatives' carelessness are, on an average, fully $20 per employee each year. Allotting one-sixth of the population of the United States as being employed in manufacturing, we have a total loss of about $28,000,000 from this class of employment.* Add to manufacturing the work of the farmer and domestic labor, and the grand total can easily reach $150,000,000 that could have been saved to the people and added yearly to our nation's wealth, had there been due care exercised in the labors or actions of the people."

Mr. West considers that the foundryman suffers more from the carelessness and inattention of his employees than he does from their ignorance and lack of skill, and that it is to the interests of the various foundrymen's associations throughout the country to prosecute a vigorous educational campaign against these evils.

"As the first organized step to make the subject of carelessness one of national issue along educational lines few measures, if any, could be more beneficial than to have our various foundrymen's associations take up the work of collecting statistics of shop accidents and losses caused by individual carelessness, so that those outside of the actual control of manufacturers could have facts to influence moral support in portraying the chief cause of casualties, and thereby aid other societies and organizations to influence legislative bodies in enacting laws and devising other agencies that would be very helpful in greatly decreasing present day casualties and insure a greater lease of life and preservation of limbs to all civilians. The above is merely a suggestion given with the belief that actions not words are what we must chiefly look to in order to achieve the reform in carelessness that should and can be brought about.

"To reduce the present great loss of life and limb in connection with that of property, some may say, use the power of discharge to discipline workers. This would help in dull times, but in brisk periods, like the past five years, when a man had to walk but a few streets to find a dozen po-

* Apparently an error. One sixth of the population is 14,000,000 persons, giving an aggregate of $280,000,000.—Ed. E. M.

sitions awaiting him, this would have little restraint.

"It would seem that with the 600,000 persons who are maimed or killed, in connection with the $150,000,000 worth of property lost yearly, and chiefly through carelessness, there would be a universal awakening to apply needed remedies. There could be better discipline in our homes and schools and societies, for the development of carefulness could be formed, but the most effective remedy that can be had would be to enact laws whereby any guilty party, whether employer or employee, can be summoned to answer charges for carelessness, and be liable to fine and imprisonment for any accidents of which they may be the cause. To support such laws we will have to educate popular opinion, as by reading such papers as this, and by the presentation of actual facts demonstrating that the great majority of accidents are due to sheer carelessness of individuals.

"Another phase of this subject is the effect that the placing of the whole responsibility and cost of employees' injuries on employers would have in debarring many with small capital from starting in business for themselves. It would kill most of such prospects for many, and few movements would do more to help make this strictly a rich man's country and take from us present advantages which permit many employees to become proprietors, all for the reason that no one of small means would dare to risk his hard earned savings to help pay for an unfortunate man's life or limbs lost through some chance accident that was beyond his employer's control.

"Some will claim that employers' liability insurance companies can be relied upon to protect employers in paying their costs of accidents. Make the new Pennsylvania law for holding proprietors wholly universal in our country, instead of the old law which excused an employer, if negligence on the part of an employee could be proved, and these insurance companies would in a few years be a thing of the past, or their rates would be so high that a small beginner could not spare the capital necessary to insure himself. Whichever way we turn, the plan of loading the whole responsibility and cost upon employers for accidents is an ill advised one, and, like a boomerang, will turn to injure also those that believed themselves furthest from harm. The courts can heavily fine the employer and those who can carry the load will endeavor, if possible, to make the consumer pay, thereby still further increasing the cost of living. How much more sensible for all to labor for every possible removal of the chief cause of accidents, which is individual carelessness, and hereby save our country's great loss of life and limb, as well as the many millions of the people's money.

"The endeavor to place the whole responsibility and cost due to individual carelessness upon the employer will have little weight in this country in preventing accidents under the present régime. It suggests the question if the public is satisfied to continue enduring its loss of millions and further lessen opportunities for small capitalists to start business, as well as taking the hazardous risk of life and limb that they must under the present unpunishable dire carelessness of so many of our employees and unresponsible citizens."

THE LABORATORY IN GOLD MINING

A DISCUSSION OF THE VARIOUS WAYS IN WHICH THE LABORATORY SERVES THE ENGINEER IN THE ECONOMICAL MANAGEMENT OF THE RAND MINES.

A. McArthur Johnston—Chemical, Metallurgical and Mining Society of South Africa.

CHEMISTRY has always been intimately associated with mining and the assayer has followed the engineer closely as a necessary factor in the successful development of mining enterprises. In most cases, however, the application of chemical science to mining has been limited to the one branch of assaying or metallurgical chemistry. But there is no doubt that the extension of the usefulness of the laboratory to the testing of the various materials used in mining work, along the same lines in which it has proved its value in large railway and manufacturing enterprises, would be of immense value, particularly in the case of companies oper-

ating on a large scale on low-grade deposits. This is the view taken on the Rand, where, within the last few years, the chemist has come to be regarded as the most important ally of the engineer in securing economy and efficiency of plant operation. The various ways in which the services of the chemist are of assistance to the engineer in the particular case of the Consolidated Gold Fields Company, one of the largest operators on the Rand, were outlined in a recent paper by Mr. A. McArthur Johnston before the Chemical, Metallurgical and Mining Society of South Africa, of which the following is a brief abstract.

To be successful the laboratory must be conceived as a sound financial concern, and the ultimate object should be the testing of all supplies used in the mine. In Britain the works chemist is scarcely tolerated, but other countries are much further advanced in this respect. Germany's attention to the work of the chemist has enabled her to outstrip her rivals in certain of the arts while the rapid progress of the United States in all branches of metallurgy is undoubtedly due to the research work done by chemists and metallurgists.

"Unfortunately the laboratory has in the past on the Rand been looked upon as an expensive luxury. The financiers naturally expect some tangible return, from an outside source, of the value expended in the initial cost and running expenses, and as it very often happens that such is not forthcoming, its importance is not appreciated. They forget that it is there that most of the initial work in experimenting and in building up data on which to base changes in running operations, is carried out. Many of the results obtained undoubtedly are negative, but if occasionally one or other idea turns up trumps then the industry is the gainer. Looked at in this way, I may safely affirm that these initial experiments cost but a mere trifle as compared with what they would cost were they attempted in actual practice and, as often happens, found wanting."

To the manager of the reduction works the laboratory can be of immense assistance. As a striking instance of the value of laboratory experiments may be mentioned the discovery that the loss of gold when working with new amalgamating plates can be greatly reduced by treating the plates with silver amalgam. To the cyanide manager tests of lime and cyanide are of importance. On the Rand these materials are bought on a guaranteed percentage basis, the former on the basis of the caustic lime content and the latter on the percentage of cyanide, calculated as KCN, and the absence of sulphides. There is little difficulty in buying cyanide of the requisite strength and purity, but the caustic lime test is a sore point with the sellers though it is the only equitable basis of purchase. Occasional tests of the working cyanide solution have to be carried out and experiments of this kind, made necessary by alterations in the ore or in crushing methods, are much better carried out in the laboratory than by the cyanide manager who usually has but little time to devote to research work.

To the engineer the assistance of the laboratory in making coal tests is of the utmost importance, and more especially so since colliery managers have combined to raise the price of coal. The ideal basis for the purchase of fuel would be that of a guaranteed minimum of steam raised per unit of weight, but so many variables enter into this question that the system is impossible of attainment. The simplest and most efficient plan is to purchase coal by proximate analysis and determination of calorific value. As the value of laboratory tests of this kind are more and more recognized, engineers place more reliance on them and less on steam raising trials. In coal testing one of the most important elements is the sample. This should always be taken in the same way and the sample taken during the discharge into the bins is undoubtedly the most reliable. Colliery samples and car samples can never be reckoned as absolute. In the Consolidated Gold Fields laboratory the evaporative factor is determined by the Mahler bomb method which is found to give extremely steadfast results. The estimation of volatile matter, fixed carbon and ash in the proximate analysis is carried out in the assay muffle. Since the calorific value of coal depends largely on the amount of ash present, coal bought under contract should be sampled daily and the ash determined.

The complete proximate analysis and calorific value test should be carried out on a weekly sample made up from the daily samples. In this way a rough daily check can be had on all the coal supplied.

Second in importance only to fuel analysis is the testing of boiler feed waters. Most of the Rand mines are obliged to use the water taken from the mines and some degree of purification or softening is absolutely essential. In installing purifying plants the services of the chemist are of the utmost importance. Many such plants have been erected in the Rand fields which are absolutely useless. The mine waters change month by month and regular analyses of these and the purified water are necessary if the plant is to give any satisfaction.

In the testing of lubricating oils the most important points to be considered are the flash point, the percentage of fatty oils present, the acidity and the gumming. The first three usually give little trouble, but the gumming test is more important, oils failing in this regard giving very unsatisfactory results in service. The film formed by gumming oils is due to the presence of resin, to oxidation, or to the presence of soaps formed by the chemical action of the free acids on the metal of the bearings. The presence of resins can be determined only by fractioning. Viscosity tests are not of much importance since most engineers are able to estimate the viscidity necessary for their special requirements. Rope greases call for some attention. Acidity must always be looked for and also the presence of grit likely to set up irritation or to interact chemically with the bearing surfaces.

In the examination of candles the aim is to determine by practical tests their value in actual working conditions. The intensity of the light, the height of the flame and the melting point are of course determined, but most attention is paid to the actual burning, the cost per hour consumed in still air and in draughts of about 60 feet per minute, noting in the latter the guttering of the wick and the hardness or softness of the candle.

The testing of Portland cements, of which large quantities are used, are carried out on an extended scale and also the testing of rubber which is of considerable importance to the engineer. Explosives as supplied on the Rand are usually of excellent quality, but laboratory tests on the blasting power of different explosives with the aid of the lead cylinder have an important application. Laboratory tests on fuse are also of value, being much quicker and less likely to lead to bad results than testing by actual experience. The microscopic analysis of metals has been introduced recently with good results.

"One of the most important of the many questions to be decided in the laboratory is that of keeping our metallurgical ideas up to date. All of you know how often, on reading of some new development on these or other fields, the desire to test this on your own account, or to prove its applicability to some of your own problems, has assailed you. Necessary apparatus for conducting these trials on a small scale is usually wanting on the mine, and a request for trying them under working conditions generally results in a curt demand to keep down costs. Setbacks in this direction are certainly not conducive to individual effort, and the heads of our industry recognize that more concerted action in this direction would be advantageous, but hitherto the sum total of this recognition has been its recognition. An 'experiments fund' was inaugurated some two or three years ago by our largest group here and, quoting a local weekly, it seems that already £15,000 has been expended in trying new devices, and that in one case an unsuitable device cost £4,500 prior to its being abandoned.

"Now, I have no hesitation in saying that quite a considerable portion of this could have been saved had the initial tests been carried out on a laboratory scale, meaning thereby a mechanical as well as metallurgical laboratory. I may be permitted to draw the attention of members, however, to one source of false conclusions which are only too liable to crop up in initial experimental work, that is, the test must represent the absolute duplication of the working conditions. That many failures on the large scale are undoubtedly due to neglecting this is only too true, and an impartial test by a thorough practical man should always be insisted on prior to money being spent in large tests. We know how prone the inventor is to overlook small de-

tails, which in themselves may latterly cause the failure of the trial. From the point of view also of the originator we find that his grievance is, that on a mine sufficient attention is not given to the carrying out of his ideas to the best advantage. As against this, the engineer, mill manager and cyanide manager usually have sufficient daily worries of their own and are sometimes inclined to afford scant courtesy to the man who increases these worries, more especially if he be a non-practical worker."

SMOKELESS COMBUSTION OF COAL.

THE ESSENTIAL CONDITIONS OF BOILER CONSTRUCTION AND MANAGEMENT FOR THE SMOKELESS COMBUSTION OF HIGH-VOLATILE FUELS.

L. P. Breckenridge—Bulletin of the University of Illinois.

THE Engineering Experiment Station of the University of Illinois has recently added to its series of valuable bulletins one on the problem of the smokeless combustion of coals of a high volatile content, particularly those of the State of Illinois. While the writer, Mr. L. P. Breckenridge, does not claim to present any new information beyond the results of careful and extensive boiler trials, the bulletin gives an extremely interesting discussion of the smoke-abatement problem, of which the following abstract is a brief outline.

Mr. Breckenridge prefaces a review of the chemical principles of combustion thus: "The problem of smoke prevention is the problem of perfect combustion. There is no such thing as smoke consumption and this term should never be used. There is such a thing as perfect combustion and this means smokeless combustion." Continuing he says:

"It may perhaps be profitable to picture an ideal perfect combustion, and then inquire in what ways actual combustion falls short of the ideal. The given fuel, composed of carbon, various volatile hydrocarbon gases, and perhaps sulphur, is to be burned in air. Theoretically, each atom of the fuel finds and seizes upon the number of oxygen atoms with which it will combine. Each atom will meet with two oxygen atoms at a temperature sufficiently high for ignition. They will combine, and the resulting CO_2 will pass out of the furnace, carrying with it the heat arising from the combustion; likewise with the hydrogen and sulphur atoms. No more air will be delivered than is just sufficient to furish the exact number of oxygen atoms, and no carbon or hydrogen atoms will pass out of the furnace without finding oxygen atoms with which they can combine.

"Actual combustion deviates from ideal conditions in many respects. If only the theoretical amount of air is supplied, on account of the difficulty of properly mingling the fuel and air, some of the fuel atoms will not find oxygen atoms, and will escape uncombined. Or some of the carbon may burn to carbon monoxide instead of to carbon dioxide, and the CO will escape without further combustion. It is found in practice that to insure complete combustion, an excess of air must be furnished. This excess is usually 50 per cent., and may reach 100 per cent.; i.e., while only 11.3 pound of air are required for the complete combustion of 1 pound of carbon, it is usually necessary to furnish 18 to 24 pounds. Since the heat of combustion is distributed throughout the excess of air introduced into the furnace as well as the products of combustion, the furnace temperature is lowered by the presence of the extra air.

"In another important particular, the actual state of affairs is likely to be quite different from the ideal combustion outlined above. Carbon and oxygen atoms will not unite unless a certain temperature, the ignition temperature, is reached. In parts of the furnace, the temperature may fall below the ignition point because of the inrush of an excess of air, or because of cold bounding surfaces. As a result, carbon particles, even in the presence of plenty of oxygen, will refuse to burn."

The products of combustion, carbon dioxide, steam and sulphur dioxide, are colorless gases. It is only when combustion is imperfect that visible smoke is produced and its appearance is due to the driving off

of volatile hydrocarbons from the heated coal. The percentage of volatile constituents in coal varies from 3 per cent. in the eastern anthracites to 50 per cent. in some of the western lignites, and the difficulty of smoke prevention increases with the amount of volatile matter. When driven off from the coal, if they encounter a sufficiently high temperature, the volatile hydrocarbons decompose into carbon and hydrogen. If sufficient air is present the hydrogen immediately combines with the oxygen to form steam and the carbon burns to CO_2. If, however, sufficient air is not admitted, the carbon, which requires favorable conditions under which to combine with oxygen, will not burn but will be carried along with the products of combustion as soot. The mere explanation of the formation of black smoke, therefore, immediately suggests the means for its prevention, namely, the introduction into the furnace of air in sufficient volume and at a sufficiently high temperature to burn the carbon particles liberated from the volatile gases. To insure proper combustion, after the gases are driven from the coal, they should intimately mingle with sufficient air in a chamber in which a high temperature can be maintained and should not come in contact with the heating surface of the boiler until combustion has been completed.

The absence of smoke does not necessarily indicate perfect combustion. It may mean simply excessive air supply. But the appearance of black smoke is the signal of incomplete combustion and uneconomical operation. The fuel loss in soot, even under the worst conditions of smoke production, is so small that it would not be worth while to provide elaborate devices to prevent this loss were it the only one. It is the prevention of the escape of the unconsumed gases indicated by the presence of smoke which is of importance hygienically and economically. Smokelessness is a fairly safe indication that the total heat of the fuel has been liberated, but it gives no indication of the degree of efficiency of heat utilization. The highest efficiency demands smokelessness with a minimum air supply.

Mr. Breckenridge described the method used for the observance and recording of smoke production and then proceeds to a discussion of the results of the extensive tests carried out during the past two years on the boiler plant of the University of Illinois. This plant consists of nine units with a total capacity of 2,000 horse power, four of the boilers being Babcock & Wilcox, three Stirling, and one each National water tube and Heine. Two of the B. & W. boilers were equipped with the B. & W. chain grate stoker and the other two with Roney stokers; two of the Stirling boilers were equipped with the Stirling bar grate stoker; the remaining units were equipped with the Green chain grate stoker. In all, over 200 separate boiler tests were made in this plant to determine furnace conditions, many changes in the constructive features of the furnaces and boiler baffling being made to admit of a thorough examination of the smoke problem. The results of these tests reveals the fact that any one of the four well-known types of boilers may be set over at least three well-known types of automatic stokers and be operated without objectionable smoke. The University of Illinois plant was operated without objectionable smoke fully 90 per cent. of the time, and Mr. Breckenridge is convinced that "any fuel may be burned economically and without smoke if it is mixed with the proper amount of air at a proper temperature." The boiler has very little to do with the smoke problem except that some types lend themselves more easily to the necessary furnace construction. The arrangements of construction and baffling which gave satisfactory results are fully illustrated and described in detail. With the Heine boiler, an exact duplicate of the one used in the government fuel tests at St. Louis except that it was mechanically instead of hand fired, over 100 10-hour tests were made on a large number of different coals and in each case absolutely no smoke was produced. Mr. Breckenridge considers that with this setting it is impossible to make smoke. He describes the process of combustion thus:

"The fresh coal, fairly uniform in size, advances slowly from the hopper along on the grate toward the furnace where the temperature is very high. The combustible volatile matter is continually being distilled from the coal, more and more rapidly, but with much uniformity, while it is passing

under the combustion arch. Some of the necessary air flows in through the coal in the hopper, more through the grate under the arch, but by far the most flows through the redhot coals on that part of the grate beyond the arch. This air is thus heated and made ready for combining with the volatile products flowing from beneath the arch, and all together mix and roll along on the bottom of the tiles forming the roof of the furnace.

"The bottom row of boiler tubes is covered with suitably formed tiles, which prevent the still actively mingling gases from being cooled by coming in contact with the tubes, and so the combustion processes go on until completed before reaching the point where the gases pass in among the cooling tubes. The tiles in the adjoining rows touch each other so that no gases pass between them."

There is an increasing tendency to drive boilers above their rated capacity, but there is a limit beyond which smoke will be produced. This limit varies for different types of furnaces and methods of baffling and for different kinds of coal, but in general it may be taken that when boilers are forced much over 130 per cent. of their rated capacity, the probability of smoke rapidly increases. It would seem necessary that when a plant has reached say 140 per cent. of its rated capacity, additional boilers should be installed, in the interests of smoke abatement, until further advances in furnace construction and operation have been made.

AERIAL NAVIGATION.

A REVIEW OF PROGRESS AND AN ESTIMATE OF FUTURE POSSIBILITIES.

Engineering News.

TO the popular mind, the attention which is now being paid to experiments in aeronautics by the military departments of a number of Governments seems to indicate that the day of successful aerial navigation is near at hand. *Engineering News,* however, in an editorial review of progress in this field in the issue of January 16, 1908, which is abstracted below, regards the complete removal of the difficulties and dangers inherent in any form of air navigation as impossible of accomplishment and doubts that the air ship will ever be developed sufficiently to have any practical application outside the sporting field and a limited use in military operations.

"Aeronautical practice of the present time easily divides itself into three lines of work with distinct types of apparatus, common balloons, dirigible gas bags and 'heavier-than-air' flying machines. No little publicity has been given to recent balloon work and while greater skill and knowledge in handling these great gas bubbles is evident than ever before, yet the apparatus is much the same as that devised and used 125 years ago.

"With balloons, far greater altitudes can be reached than it seems probable any true airship could possibly attain. The simple balloon has greater inherent safety and stability than any dirigible or airship and greater ease of control in so far as it can be controlled at all.

"The desire to make an airship which can go where its navigator desires and not simply float with the winds has led to the various dirigibles with their peculiar elongated supporting body and comparatively small propelling and steering apparatus." Among the early experimenters Giffard (1852), Dupoy de Lome (1872), and Tissandier (1883), built dirigibles and operated them with some success. The immediate prototype of the successful dirigibles of the present day was, however, the "La France" of Renard and Krebs, whose feats have not been greatly exceeded.

"Among the most notable experiments with dirigibles should be noted those of Alberto Santos-Dumont which resulted in his winning the Henri Deutsch prize of 100,000 francs at Paris in 1901. His designs were evidently founded on the work of Renard and Krebs; and while it is often stated that his gas bag itself was in many ways inferior to that of 'La France,' yet with a superior source of power their record was greatly exceeded. Santos-Dumont travelled from St. Cloud to the Eiffel Tower with the wind in 8 minutes 45 seconds, circled

the tower and returned against the wind in 20 minutes 30 seconds and descended in 1 minute 40 seconds. His gas bag was smaller than that of 'La France,' being 111.5 feet long by 20 feet maximum diameter. The propelling screw was 13 feet in diameter and was driven by a 16-horse-power gasoline motor at 200 revolutions per minute. Space can hardly be given to an enumeration of all the subsequent dirigible balloons which have been wholly or partially successful. However, the names of Von Parsifal and Count Von Zeppelin, both in Germany, and of Henri Deutsch, Count de La Vaulx, the Lebaudy brothers and their engineer Julliot, all in France, should be mentioned as noteworthy experimenters. . . . . .

"Sir Hiram S. Maxim's big aeroplane is credited as being the first true flying machine to leave the ground. The lifting power developed overcame the restraint put upon its ascent and it was wrecked in consequence of its overdoing. When Maxim first started his experiments little was known of the properties of aeroplanes and aerial propellers and the modern internal combustion engine was entirely undeveloped. A steam boiler and engine were designed, remarkable for lightness in comparison to the boiler and engines of that time. This apparatus was the forerunner of the steam-automobile boiler and engine as they exist now. By 1890 Maxim's investigations were well under way and his power apparatus was all designed. In 1894 Maxim gave an exhibition of a huge machine weighing, when loaded with three men, 200 pounds of naphtha fuel and 600 pounds of water, a total of about 8,000 pounds. A wing area of some 4,000 feet was designed to develop a lifting force of 10,000 pounds. It will be remembered that the machine broke through the inverted track, intended to limit its flight for these experiments, turned crosswise and was so badly wrecked that little further has been done with it. The results of this pioneer work, however, became available to later experimenters and have served as a basis of later developments.

"The next important contributions to the science were in the efforts from 1890 to 1895, of the late Professor S. P. Langley, Secretary of the Smithsonian Institution at Washington. The experiments with model 'aerodromes' were entirely successful, but the manipulation of the full sized machine brought practical difficulties which were not surmounted through lack of funds when the death of the inventor occurred. Langley's large machine was 12 feet long and 8 feet wide with four stationary wings and a steering pair about half the size of the larger ones. Steam power was used to drive two small wooden propellers. Mr. Chas. M. Manley, for seven years associated with Professor Langley on this work, is authority for the statement that the failures were of the launching apparatus rather than of the 'Aerodrome' itself and that the work with this type has not been abandoned but only suspended. Langley's experiments are admittedly the most thorough and scientific ever made in this field and, while no practical commercial machine was developed, the design of lifting planes was placed on a more exact and well defined basis."

About this time also Lilienthal came into notice with his "artificial birds," huge, soaring kites which were intended to imitate the flights of certain birds. His experiments were not very successful, but he laid the foundation on which his successors in this line of work, Chanute, Herring and especially the Wright brothers, have brought the sailing type of air ship much nearer practical success.

"Santos Dumont not satisfied with his success with dirigible balloons turned his attention to aeroplane flyers. His arrangement seems to be two lateral sections like double-decked wings with a box-kite-like rudder attached to a long lever in front of the machine. A 50-horse-power eight-cylinder gasoline engine drives a small screw propeller in the rear. The greatest flight obtained with this machine is stated to have been 300 yards.

"Occasional press notices for a few months back have chronicled the experiments of Henry Farman in Paris. The latest report is that on Jan. 13 he made a circuit of about 1,300 meters and won the Deutsch-Archdeacon prize which was offered for the first 'heavier-than-air' machine to cover a circular kilometer. It is stated that this aeroplane weighs about 300 pounds. A frame of ash and piano wire seems to be arranged much in the form of the Wright flyer in this country. A for-

ward rudder like Santos Dumont's scheme is provided. An eight-cylinder, 50-horse-power gasoline motor, weighing about 175 pounds, is used for propulsion. The final trial for the Deutsch-Archdeacon prize was held a few miles outside Paris in the presence of members of the French Aero Club, several noted aeronauts and about 500 spectators. It is stated that the machine sailed gracefully, about 30 feet above the ground, at a speed of some 25 miles per hour."

Passing mention should also be made of Dr. Alexander Graham Bell's experiments with kites made up of tetrahedral cells. Recent trials with a large model carrying a man are reported to have shown this type to be very stable in the air and experiments with gasoline motor propulsion are to be undertaken at once.

"There is a good deal of misconception as to the probable field for successful aerial navigation. To the lay mind anything is possible, and the 'navies battling in the blue' appears a reasonable probability of the future. The engineer, however, realizes the inherent dangers and difficulties of any form of air navigation. No invention or ingenuity can neutralize the danger to a body poised in mid air and dependent only upon the supporting power of the air to save it from a disastrous fall to the earth. No invention or ingenuity can make safe the navigation of a medium subject to such commotions as hurricanes and tornadoes. By no possibility can carriage of freight or passengers through mid air compete with their carriage on the earth's surface.

"The field, then, for aerial navigation is limited to military use and for sporting purposes. The former is doubtful; the latter is fairly certain. As regards the former, it will be recalled that military balloons have been in use for more than half a century; and that modern high-power, long-range guns have greatly limited the usefulness of such methods of observation. There is every reason to believe that the same thing will limit the usefulness of the military dirigible balloon or flying machine. As for the use of any form of aerial navigation for carrying messages, the development of wireless telegraphy and telephony appears to have blocked all prospect of success there.

"The sporting field is therefore the real field at which the flying machine inventor is aiming. Already ballooning and driving dirigibles are among the most popular fads of the sporting set in Paris. Aside from this the imitation of the birds has fascinated thousands and millions of people to an extent that makes certain that the search for a successful flying machine will go steadily on, even though there be no prospect of great commercial returns to the inventor."

ELECTRIC WELDING.

A DESCRIPTION OF THE BENARDOS PROCESS AS APPLIED TO THE REPAIR OF DEFECTIVE STEEL CASTINGS.

C. B. Auel—The Electric Journal.

WITHIN recent years the steel casting has replaced the iron casting in the construction of machinery of all kinds on account of its comparatively light weight for a given service, but it still fails to equal the iron casting in reliability. There are certain defects of steel castings, such as blow holes and mis-running at the high points of the mould, that no refinements of moulding and pouring seem to be able effectually to guard against. These defects are the more troublesome to the purchaser in that they rarely appear on the surface and are disclosed only on machining, and the loss of time and money in machining and the delay in replacing defective castings have been the cause of much inconvenience and dissatisfaction. In *The Electric Journal* for January, 1908, Mr. C. B. Auel describes a novel application of the Benardos process of electric welding which should remove a great deal of this inconvenience by permitting the purchaser to make his own repairs rapidly and cheaply. The apparatus and processes are described in the following abstract of Mr. Auel's paper.

In the Benardos process the metal to be welded forms one terminal of an electric circuit and an arc is drawn between it and

a carbon electrode which forms the other terminal. The requirements for the welding of steel castings are a direct current source of supply, a rheostat, a carbon electrode and fire clay or carbon blocks for moulding purposes. Welding operations are best carried on in an isolated part of the shop owing to the intense glare of the arc, and the body of the operator should be protected against the rays of the arc. the effects of which are somewhat similar to sunburn. The hands should be covered with heavy gloves and the head with a canvas hood with a window of colored glass.

Current up to 220 volts may be used, but this voltage is very wasteful of power. Most economical results are obtained with a 110 to 125 volt current. Where there is enough welding to be done to keep one man steadily employed, the current should be taken from an independently driven dynamo of 75 to 100 kilowatt capacity at 100 to 125 volts instead of from the supply mains. With the dynamo should be provided a small switchboard with the necessary instruments.

"The rheostat may be of the grid type, though a very satisfactory one is easily constructed by using two water-tight barrels placed side by side. The positive cable of the circuit is carried from the dynamo to the switchboard and from the switchboard to the water rheostat. At the rheostat this cable divides into two smaller ones, these being fastened to separate triangular steel plates not less than one-fourth inch thick, suspended above the barrels by means of pulleys and counterweights, so that the plates may be readily lowered into or withdrawn from the barrels as occasion requires the adjusting of the water resistance. Similar cables are run down the inside of each barrel and one end likewise fastened to a heavy plate of steel, which lies on the bottom. The other end of each of these cables is attached to the casting to be welded or the cables may be fastened to a metal cable and the casting simply laid upon it, always providing good contact is made. Discarded steel castings may be substituted for the steel plates in the bottom of the barrels. They should weigh about 20 or 30 pounds each and not occupy too much room. The negative cable of the circuit is carried from the dynamo to the switchboard and from the switchboard to the vicinity of the casting to be welded, where it is provided with a metal terminal and clamp into which the carbon electrode is tightly fitted. In order to manipulate the carbon electrode during welding, the negative terminal is held in a wood insulating handle, to which is attached a shield of asbestos or other fireproof insulating material. The exact form of the terminal and clamp, the insulating handle and shield or the terminal plates of the water rheostat is immaterial, as is the method of attaching the cables to their respective terminals as long as good and sufficient contact is made, thus preventing undue heating at the joints."

The selection of the proper carbon requires some care. If the carbon flakes and crumbles under the hard treatment to which it is subjected the pieces falling into the weld produce a high-carbon steel which is very difficult to machine. The best results are obtained with a hard solid carbon one or one and one-half inches in diameter and six to twelve inches long, which will wear to a round blunt end instead of a long pencil point.

For the repairing of steel castings it is preferable to use for filling Norway iron rods, about ⅜ inch in diameter, though for small welds small pellets from steel scrap may be used.

"The positive terminal of the circuit may be clamped directly to the casting to be welded or it may simply be laid upon a metal table and the terminal clamped to the latter. The positive terminal is thus connected instead of the negative terminal so as to direct the flow of current from the casting to the carbon electrode, and in this way prevent carbon, when the electrode is vaporized, from entering the weld. The steel plates of the water rheostat are lowered into the barrels which have been previously filled with water, the circuit breaker and the switch closed, when the actual welding is ready to be undertaken.

"The operator places himself directly in front of the casting, holding the negative terminal with its carbon electrode in one hand by means of the wood insulating handle, and having within reach of the other several pieces of iron rod. He then pulls the canvas cap well down over his head,

touches the carbon to the casting, thereby closing the circuit and thus producing an arc. As soon as the arc is sprung, the carbon is withdrawn to a distance of two inches or more (too short an arc will tend to produce a hard weld), and the arc allowed to play upon the casting until the metal commences to boil. It is advisable not to concentrate the arc on any one spot, but to give it a circular movement so as to heat the casting very thoroughly within the immediate vicinity of the proposed weld. This will tend to prevent too rapid cooling of the metal with its consequent chilling and hardening effect. The end of one of the iron rods is now placed directly in the midst of the boiling metal, where it gradually melts and mixes with it, the arc meanwhile being continued. As the rod melts away it is fed into the weld and this process is continued with one or more additional pieces of rod until the weld has been completed. The surface of the weld may be hammered as it cools off to produce a closer grain or to make it conform to some particular shape."

Besides the repairing of steel castings there are many other applications in which the Benardos process will give thoroughly satisfactory results commercially. Among these may be mentioned the removal of surplus metal, the boring of large holes in castings or plates and the welding of flanges, elbows and couplings to pipes. It can be learned by any workman of average ability in a few weeks time.

THE RESISTANCE OF THE AIR

THE METHODS AND RESULTS OF M. EIFFEL'S EXPERIMENTS AT THE EIFFEL TOWER IN PARIS.

Revue de Mécanique.

AN exact knowledge of the value of the resistance offered by the air to moving bodies is of importance in many branches of engineering. In the propulsion of vehicles of all kinds, the resistance of the air is one of the most important forces to be overcome, as, for example, in aerial navigation and railway traction, to mention two of the most obvious fields in which such knowledge is necessary. Many experiments have been made to establish exact data on the subject, but the results have given such widely divergent values that none of them can be taken as finally authoritative. During the last three years, however, M. Eiffel has carried out at the Eiffel tower in Paris an extensive series of very careful investigations which, from the uniformity of the results obtained, may be fairly considered as the most important contribution to the subject. The following details of these experiments are taken from the *Revue de Mécanique* for December, 1907, after M. Eiffel's recent publication of his result in book form.

The experiments were carried out from the second story of the Eiffel tower at a height of 120 metres from the ground. The body dropped from this height weighed 120 kilogrammes. The fore part of the weight consisted of the surface under test and behind this was placed a conical box containing the delicate measuring instruments. The most difficult problem in connection with the experiments was to devise a means of stopping the weight without damage to the apparatus. In the arrangement finally adopted the apparatus slid along a smooth cable held perfectly vertical. About 20 metres above the ground a progressive enlargement of the cable began and this enlargement by opening a series of jaws connected to powerful springs carried by the apparatus, brought the weight to a stop by a perfectly regular braking action in a distance of ten metres.

During the fall the apparatus was connected to the surface under test by carefully calibrated springs which acted as a dynamometer. The action of the springs being antagonistic to the resistance of the air on the surface, the resistance could be deduced from the displacement of the surface with respect to the rest of the apparatus. This displacement was indicated by a stylus attached to the surface under test and resting lightly on a vertical blackened cylinder carried by the apparatus. The cylinder rotated about its axis, the rotation being produced by a very fine toothed roller

held against the cable by a spring. The rotation of the cylinder was in each case proportional to the height of the drop and the line traced upon it showed the tension of the dynamometer springs at each instant.

The aim of the investigations, however, was not to ascertain the resistance of the air for every point of the drop but for each variation in speed. Hence the stylus was mounted on a tuning-fork making 100 vibrations per second, so that in addition to registering the tension of the springs and the distance traversed, it indicated also the elapsed time from the beginning of the fall. The fine sinusoidal curve traced on the cylinder showed, therefore, the three elements of the problem, space, time and the tension of the springs; the speed was deduced from the first two and the resistance of the air from the third. The calculations were made by an extremely simple yet accurate graphical method.

All diagrams which showed the slightest indication of inaccuracy were rejected and in making the experiments the utmost possible precautions were taken to secure accurate results, particular attention being paid to the protection of the falling weight from air currents. Repeated tests were carried out on each surface at different times in order to eliminate the possibility of accidental errors in the apparatus. The results in each case were reduced to their equivalent at a temperature of 15 degrees C. and a pressure of 760 millimetres. The experiments were carried out between the speeds of 18 and 40 metres per second, or 65 to 144 kilometres per hour.

M. Eiffel summarizes the results as follows:

"We have established that, within the limits of the investigations, that is, for speeds between 18 and 40 metres per second, the resistance of the air is approximately proportional to the square of the velocity. In reality, the exponent of the speed, for plates, seems to increase continuously and to reach the value 2 for a speed of about 33 metres per second; but in all cases the value is so close to 2 that for all practical purposes this figure can be taken as correct and the resistance of the air in kilogrammes can be represented by the product KSV^2, where K is a coefficient depending only on the surface, S the surface of the plate in square metres and V the speed in metres per second.

"We have not found for the coefficients K the high values, reaching 0.13, proposed by some experimenters and used by many engineers. Our investigations, repeated under many varying conditions and giving results of remarkable uniformity, seem to us to establish the value of the coefficients as between 0.07 and 0.08, at a temperature of 15 degrees C. and a pressure of 760 millimetres. The latter value appears to be a maximum only attained in plates of very large dimensions."

COMPRESSION AND EFFICIENCY IN GAS ENGINE OPERATION.

A SUMMARY OF THE RESULTS OF TESTS CARRIED OUT BY THE GAS ENGINE RESEARCH COMMITTEE OF THE INSTITUTION OF MECHANICAL ENGINEERS.

Prof. F. W. Burstall—Institution of Mechanical Engineers.

THE third report of the Gas Engine Research Committee of the Institution of Mechanical Engineers, presented to the Institution by Prof. F. W. Burstall at the meeting of January 17, deals with the relation between compression and thermal efficiency. As shown by the following extracts, which summarize the conclusions reached by the Committee, the results of the investigations do not support the common belief that a high compression is necessary for economy.

A Premier scavenging engine was used in the investigations. It developed 150 horse power at a speed of 170 revolutions per minute, the size of the cylinder being 20 inches in diameter by 24 inches stroke. In order to enable the engine to run at a compression pressure of 200 pounds per square inch, with charges which were estimated to give an initial pressure of 600 pounds, the diameter of the cylinder was reduced to 16 inches. The compression was varied by altering the length of the connecting rod, or by bolting packing pieces or junk pieces at the back of the piston.

"The working of the engine is as follows:—Starting with the suction stroke, the combined air-and-gas valve is opened to a predetermined point by a pivoted lever under the control of the governor and a positively driven pecker block, actuated by the half-speed shaft, the governor thus controlling the opening of the air-and-gas valve. The mixture, after passing through this valve, enters through the breech end into an annular casing, which contains the inlet valve, and then into the cylinder itself. After shutting the inlet valve the usual sequence of compression, explosion, expansion, and exhaust follows, but about half-way along the exhaust stroke a second valve, scalled the scavenger valve, lying alongside the mixing valve, is opened from the lay shaft, and allows a current of cold air from the differential piston to enter into the motor cylinder. This serves the double purpose of clearing out the exhaust products, and at the same time cooling the inner surfaces. During the idle stroke of the engine this scavenging charge is simply compressed and expanded in the passages leading up to the mixing and scavenger valves. In order to prevent, as far as possible, any possibility of pre-ignitions occurring through hot surfaces, every part of the engine exposed to the flame is water-jacketed, and in order to estimate the amount of heat rejected through each of these surfaces, the water services are taken from separate measuring tanks, and discharged without a mixture from water from any other surface. The temperatures of discharge were in each case measured by thermometers placed in the outlet pipes.

"The tests were undertaken to determine in the first place the thermal efficiencies based on the indicated horse-power, at various compressions, having regard to the richness of mixture, and in the second place to formulate if possible the law connecting efficiency and compression. Thus at each compression it was proposed to run a series of trials with different mixtures, which was done by using a number of different mixing valves in which the ratio of the air and gas ports varied. Had the composition of the gas throughout the tests been uniform this would have been a simple matter, but as the producer plant was in general worked at a fairly light load, it was impossible to ensure beforehand that the composition of the gas should be exactly what was required for the particular valve employed. The calorific value of the gas aimed at throughout the tests was 160 B.Th.U. per cubic foot (lower value).

"The heating values were obtained not only from the analysis of a sample drawn continuously throughout the whole of the tests, but also from the Junker calorimeter, which also ran continuously. During the preliminary tests it was noticed that the values from analysis and from the calorimeter did not agree, and that they varied capriciously. As the lower value deduced from the calorimeter necessitated the determination of the amount of water condensed, and this quantity varied according to the hygrometric state of the atmosphere, it was considered essential that the calorimeter should either work with dry air and dry gas or saturated air and saturated gas, and the latter condition was chosen. In this particular calorimeter, both air and gas are led through coke-packed towers, over which a stream of water is steadily trickling, so that they issue from these towers saturated. From these the air and gas are led through a coil of pipe placed in the outlet of the calorimeter, so that incoming air, incoming gas, and outgoing products of combustion are automatically reduced to the same temperature.

"In all other respects the calorimeter was used as was customary. This arrangement had the effect of giving the amount of the condensed water in the calorimeter a closer value than usual to that obtained from analysis, and also produced a remarkably close agreement between the calorimeter values calculated from analysis and those observed.

"Considering the thermal efficiencies shown in the tabulated results it is apparent that for each compression there is a particular mean pressure which gives the highest economy for that compression. This pressure appears to range between 85 lb. and 95 lb. for all the compressions, with the tendency to increase as the compression goes up. Higher mean pressures than these caused the efficiency to fall off. This result does not accord with the usual belief that economy increases with compression, when a suitable mixture is used. The

cooling action of the walls, however, affects the result materially. Consider the contents of the cylinder at the end of compression. The gas is confined in a space 16 inches in diameter, at the highest compression about 3¼ inches long, and at the lowest compressions about 6½ inches long, the gas being entirely surrounded by water-cooled surfaces. This being the case, the leakage of heat during compression will be greater proportionately at the high than the low compressions, because the higher compression is accompanied by a higher density and by a temperature difference between the walls and the charge, and this more than compensates for the reduction of the area of surface exposed to the gases. Hence, after some definite compression is reached, further compression will result in a loss of economy and not a gain. For this particular engine the most economical compression pressure is apparently 175 pounds per square inch; but, of course, the particular compression that will give the highest economy will vary according to the design of the clearance spaces, but it does not seem to be probable to get a design which will give better results than in the engine experimented upon.

"In order to obtain higher thermal efficiencies by the aid of higher compressions, it would be necessary to increase the stroke of the engine in proportion to its diameter. In the particular engine experimented upon the stroke is one and a-half times the diameter. If the stroke were twice the diameter, it might be possible to employ a higher compression pressure. In this way the disc of hot gas might still be kept fairly thick, but, of course, such a method would mean slower speeds of rotation for a given piston speed, and thus it is quite probable that the lower speed of rotation might produce prejudicial effects, which would more than counterbalance the gain due to heat losses. Very high mean pressures, extending to some 114 pounds per square inch, were proved to be very decidedly uneconomical, the economy falling from 39 per cent. to nearly 32 per cent. in some cases.

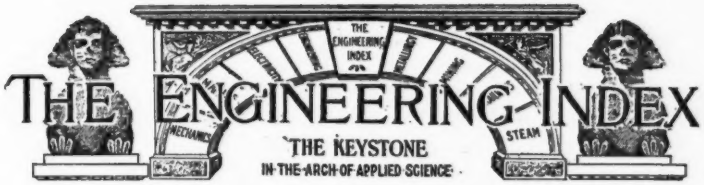
"In the actual tests the maximum pressure that was allowed was 550 pounds, and this was only rarely reached. The heat rejected to the cooling water does not represent the whole of the heat lost to the walls, because the scavenger charge carries some portion of heat from the interior walls of the cylinder, and that heat is thrown into the exhaust. Hence, the values found for the heat rejected into the jacket water are lower than those which are generally obtained for non-scavenger engines.

"The whole of the experiments appear to point conclusively to the fact that the most economical mean pressure is very considerably below the maximum which can be obtained, and that the highest economies are obtained with a comparatively low maximum temperature. Both these results imply that the engine should not only be subjected to lower pressure, but to lower temperatures as well, and thus many of the difficulties which arise in large engines from rich charges might be avoided, and the maximum pressures kept down to quite reasonable limits.

"This, of course, only applies to the indicated power, and the conclusions as to the brake horse-power would be widely different. If, however, the engine is constructed to work only with these moderate pressures and temperatures, the whole of the working parts might be very much lightened, and thus a good mechanical efficiency obtained with the very moderate mean pressures.

"The question of the liability to premature ignitions, of gas containing larger or smaller percentages of hydrogen, was borne in mind throughout these experiments, but in every case of premature ignition which occurred—and many such cases occurred—with compressions higher than 160 pounds per square inch, it was traced to dirt or carbonised oil in the cylinder, or to some part having got overheated, and such premature ignitions took place equally with a weak as with a rich gas.

"The reporter is of opinion that, as far as premature ignition goes, the compression might be made a great deal higher than any which have been used during these experiments, but in view of the fact that the economy falls off after a certain point, there does not seem to be any useful object gained in going to any higher compression."



The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

See Reinforced Concrete, under Bridges.

Bascule.

The Ohio St. Bascule Bridge at Buffalo, N. Y. Illustrated detailed description of a bridge built after the patented design of Thomas E. Brown. 2800 w. Eng News—Jan. 16, 1908. No. 89565.

DoubleTrack Trunnion Bascule Bridge Over Bodine Creek, Staten Island Rapid Transit Railway. Illustrated detailed description of a counterweighted bascule bridge of the Strauss pattern. 1500 w. Eng News—Jan. 16, 1908. No. 89567.

Blackwell's Island.

The Construction of the Queens Approach to the Blackwell's Island Bridge. Describes methods of work in the construction of a steel viaduct structure, carrying a roadway, sidewalks, and 6 railroad tracks. Ills. 1500 w. Eng Rec—Jan. 11, 1908. No. 89465.

We supply copies of these articles. See page 1103.

Columns.

Safe Stresses in Steel Columns. J. R. Worcester. Brief review of the history of the development of the column formulæ used in bridge specifications, and presents a new formula. 2000 w. Pro Am Soc of Civ Engrs—Jan., 1908. No. 89824 E.

Twelve Tests of Carbon-Steel and Nickel-Steel Columns. J. A. L. Waddell. Gives data relatng to tests recently made of full-size compression members to determine the strengths of nickel-steel and carbon-steel. Ills. 4000 w. Eng News—Jan. 16, 1908. No. 89569.

Compression Members.

See Columns, under BRIDGES.

Drawbridges.

Temporary Jack-Knife Drawbridge Over Bronx River on the New York, New Haven & Hartford R. R. Illustrated description. 3000 w. Eng Rec—Jan. 4, 1908. No. 89356.

Minimum End-Lift Device of a German Swing-Bridge. Illustrates and describes an arrangement used on a bridge at Oldenburg, Germany. 1000 w. Eng News—Jan. 9, 1908. No. 89422.

Erection.

See Steel, under BRIDGES; and Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Foundations.

Foundation Work for Six Lift Bridges. C. M. Ripley. Illustrates and describes work made necessary by the construction of the new East Chicago Canal. 1200 w. Eng Rec—Jan. 11, 1908. No. 89466.

Latticing.

Proportioning of Lattice Bars. Discussion, opened by H. S. Prichard. 5000 w. Pro Engrs' Soc of W Penn—Dec., 1906. No. 89501 D.

Riveted Lattice for Railroad Bridges of Maximum Span; A Plea for a Return to Rational Design. George Huntington Thomson. Also editorial. Aims to give the consensus of opinions representative of the "lattice school" of engineers. 4800 w. Eng News—Jan. 23, 1908. No. 89807.

Lift Bridges.

See Foundations, under BRIDGES.

Plate Girders.

Experimental Determination of Stresses in Web Plates and Stiffeners of Plate Girders. F. E. Turneaure. Presents results of experiments on plate girder webs and stiffeners, with theoretical discussion. Ills. 6000 w. Jour W Soc of Engrs—Dec., 1907. No. 89551 D.

Quebec.

Summary of the Quebec Bridge. Frank W. Skinner. Describes the design, construction, and failure. Ills. 2200 w. Cornell Civ Engr—Dec., 1907. No. 89687 C.

Reinforced Concrete.

Method and Cost of Constructing a Concrete Ribbed Arch Bridge at Grand Rapids, Mich. A bridge consistmg of 7 parabolic arch ribs of 75 ft. clear space and 14 ft. rise. 1000 w. Engng-Con—Jan. 8, 1908. No. 89431.

See also Steel and Viaduct, under BRIDGES.

Steel.

The Proportioning of Steel Railway Bridge Members. Discussion of paper by Henry S. Prichard. 11000 w. Pro Engrs' Soc of W Penn—Dec., 1907. No. 89500 D.

Erection of the Long Plate Girders of the Towanda Bridge. Illustrated description of work on the 14-span plate girder bridge across the Susquehanna River. 500 w. Eng News—Jan. 30, 1908. No. 89922.

New Bridges Over the Nile at Cairo. States the requirements of the designs and gives an illustrated description of the steel-girder bridge and the tests imposed by the Government. 3300 w. Engng—Jan. 10, 1908. No. 89653 A.

The Development of the Soudan. An account of the steel-truss bridge to be built over the Blue Nile at Khartoum, and an illustrated description of the design. 1200 w. Engr, Lond—Jan. 3, 1908. No. 89530 A.

The Construction of the Marien Bridge in Vienna (Die Bauausführung der Marienbrücke in Wien). Karl Brenner. Details and historical sketch of the construction of this steel arch highway bridge. Ills. 3300 w. Zeitschr d Oest Ing u Arch Ver—Dec. 20, 1907. No. 89751 D.

The Steel and Concrete Bridge over the Mouth of the Guindy at Tréguier (Pont en Acier et Béton sur le Guindy Maritime, à Tréguier). M. Harel de la Noé. A steel, three-pin arch, resting on steel and concrete supports, and floored with reinforced concrete. Ills. 9000 w. Ann des Ponts et Chauss—1907—IV. No. 89710 E + F.

See also Bascule, Blackwell's Island, Columns, Drawbridges, Latticing, Plate Girders, Quebec, Struts, Suspension, and Viaducts, under BRIDGES.

Struts.

The Design of Struts. W. E. Lilly. Considers the problems involved in the design of a strut, pointing out in what way the usually-applied formulæ fail to give correct values when estimating its strength; also examines the causes to which the failure of the Quebec bridge may be attributed. Ills. 3300 w. Engng—Jan. 10, 1908. No. 89652 A.

Suspension.

Erection of the Manhattan Bridge Across the East River. Illustrated de-

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scription of features, and methods of erection of this bridge, which is said to be the heaviest and strongest ever built. 2000 w. Sci Am—Feb. 1, 1908. No. 89928.

Viaducts.

Reinforced Concrete Railroad Viaducts at Seville, Spain. E. Ommelange. Illustrates and describes viaducts and wharves of reinforced concrete on a private line for the Spanish Cala Iron Co. 1000 w. R R Gaz—Jan. 17, 1908. No. 89587.

Curved Viaduct Leading to the Austerlitz Bridge (Viaduc Hélicoidal d'Accés au Pont d'Austerlitz). L. Biette. An illustrated description of this steel-truss viaduct in Paris. 3500 w. Génie Civil—Dec. 7, 1907. No. 89723 D.

CONSTRUCTION.

Brickwork.

Brickwork Details. Halsey Wainwright Parker. An illustrated series of articles on the ornamental possibilities of brickwork. 1800 w. Br Build—Dec., 1907. Serial. 1st part. No. 89285 D.

Buildings.

See Concrete, and Steel Buildings, under CONSTRUCTION.

Columns.

See same title, under BRIDGES.

Concrete.

An All-Concrete Laundry Building. Illustrated description of a 4-story structure in Salem, Mass. 2000 w. Eng Rec—Jan. 11, 1908. No. 89464.

Concrete Building Stone. C. A. P. Turner. Illustrated description of a new material, its process of manufacture and some of the uses. 3000 w. Cement Age—Jan., 1908. No. 89684 C.

Concrete of Exposed Selected Aggregates. Albert Moyer. Illustrates and commends a house in South Orange, N. J., describing its construction. 2200 w. Munic Engng—Jan., 1908. No. 89485 C.

On the Influence of Temperature on Masonry, Cement and Reinforced Concrete Construction (Sull Influenza della Temperature nelle Costruzioni in Muratura, Cemento e Cemento Armato). Ills. 3000 w. Il Cemento—Nov., 1907. No. 89703 D.

See also Concrete Testing, under MEASUREMENT; and Locks, under WATERWAYS AND HARBORS.

Contracts.

Substantial Performance of a Building Contract. George Doan Russell. Considers some of the cases which arise in courts, and discusses the legal side of building operation. 3500 w. Columbia Engr—1906. No. 89498 N.

Earthquakes.

Effect of Earthquake Shock on High Buildings. R. S. Chew. A study and statement of conclusions as to the type of construction for the vicinity of San Francisco. 1500 w. Pro Am Soc of Civ Engrs—Jan., 1908. No. 89825 E.

Earthquakes and Their Relation to Engineering Construction (Die Erdbeben in ihren Beziehungen zur Technik und Baukunst). Dr. Franz Ritter. The first part of the serial discusses the vast amount of damage that has been done by earthquakes and reviews literature on the subject. Serial. 1st part. 6000 w. Zeitschr d Oest Ing u Arch. Ver—Dec. 6, 1907. No. 89750 D.

Excavation.

Comments on the Use of the Mattock. Deals with the use and misuse of this earth-working tool. 1800 w. Engng-Con—Jan. 15, 1908. No. 89581.

Factories.

Doubling a Factory's Floor Space. C. M. Ripley. Describes an interesting piece of work just completed at Passaic, N. J. A new structure was built over a wing without interruption of the operation of the old plant. 1000 w. Eng Rec—Jan. 18, 1908. No. 89614.

See also Shops, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Failures.

Failures of Reinforced Concrete. H. F. Porter. Aims to clearly set forth the causes of the failure of the Kodak Building in Rochester, N. Y., and probably of other structures. 2800 w. Cornell Civ Engr—Dec., 1907. No. 89688 C.

Fireproof.

An Analysis of the Fire in the Parker Building, New York City. Peter Joseph McKeon. Describes the construction of the building and course of the fire, stating the conclusions. 1500 w. Eng News—Jan. 16, 1908. No. 89573.

See also Fire Protection, under WATER SUPPLY.

Regulations.

Regulations of the Bureau of Building Inspection in Regard to the Use of Reinforced Concrete. Emile G. Perrot. Gives the text of the new regulations now in force, discussing some of the important features. General discussion. Ills. 9500 w. Pro Engrs' Club of Phil—Oct., 1907. No. 89548 D.

Reinforced Concrete.

Notes on Reinforced Concrete. Discusses concrete in compression, grooped columns, allowable stresses, etc. 3000 w. Jour Worcester Poly Inst—Jan., 1908. No. 89695 C.

Something About Reinforced Concrete. E. Horton Jones. Discusses its qualities, application, and uses. 1800 w. Min Sci—Jan. 16, 1908. No. 89634.

We supply copies of these articles. See page 1103.

Reinforced Concrete from the Contractor's Standpoint. H. H. Fox. Read before the Nat. Assn. of Cement Users. How to make the best possible reinforced concrete. 2500 w. Eng News—Jan. 30, 1908. No. 89926.

A Reinforced Concrete Observation Tower. Illustrated description of a tower recently erected at Vicksburg, Miss. 900 w. Eng Rec—Jan. 25, 1908. No. 89831.

The Stadium of Syracuse University. Illustrated description of the recently completed reinforced concrete stadium for athletic games. 4000 w. Eng Rec—Jan. 18, 1908. No. 89617.

The Influence of Bond on Size of Reinforcement Bars for Concrete. William P. Creager. Aims to provide a rational method of determining the maximum size of the bar that can be used in any given span and system of loading, consistent with the adopted working intensity of adhesion or bond stress in the bar. 1200 w. Eng Rec—Jan. 25, 1908. No. 89830.

The Choice of Diameter for Round-Iron Reinforcement (Beitrag zur Berechnung der Haftspannungen und Ermittlung der entsprechenden Rundeisendurchmesser). Rich. Wuczkowski. A mathematical discussion on the design of reinforced-concrete beams with round-iron reinforcement. Ills. 2500 w. Beton u Eisen—Dec., 1907. No. 89775 F.

Recent Researches in Reinforced-Concrete Construction (Neuere Forschungen im Gebiete des Eisenbetonbaues). M. Foerster. Discusses principally the Considére system of reinforcement and new types of reinforcing metal. Ills. 4500 w. Stahl u Eisen—Dec. 4, 1907. No. 89729 D.

The Tensile Strength of Concrete in Reinforced-Concrete Structural Design (Berechnung der Eisenbetonbauten unter Berücksichtigung der Zugspannungen des Betons.) Chr. Vlachos. A mathematical paper, reviewing the researches of Wayss and Freytag, and Schüle on the ratio $n = E_c/F_b$. Ills. 3500 w. Beton u Eisen—Dec., 1907. No. 89777 F.

See also Failures and Regulations, under CONSTRUCTION; Reinforced Concrete, under MATERIALS OF CONSTRUCTION; and Conduits and Reservoirs, under WATER SUPPLY.

Stacks.

A Tall Brick Chimney with Acid-Proof Lining. Illustrates and describes the 366-ft. brick chimney of the Eastman Kodak Co., Rochester, N. Y., for carrying off strong acid fumes. 1500 w. Eng Rec—Jan. 4, 1908. No. 89357.

Steel Buildings.

The New Hearst Building, San Francisco, Cal. Illustrated description of the engineering features of a steel-cage building to be built in an earthquake district. Plates. 2500 w. Am Archt—Jan. 18, 1908. No. 89664.

Structural Features of the Warwick Shops of the Lehigh and Hudson River Ry. A steel and concrete building at Warwick, N. Y., is illustrated and described. 2500 w. Eng Rec—Jan. 11, 1908. No. 89468.

See also Columns, Latticing and Plate Girders, under BRIDGES.

Tunnels.

Method of Drilling and Mucking in a Rock Tunnel and a Comparison in the Tunneling on the Rand. Abstract of articles by W. P. J. Dinsmoor. 2500 w. Engng-Con—Jan. 1, 1908. No. 89314.

The Bernese Alpine Tunnel (Lötschbergbahn). Fritz Hromatka. Illustrated description of a line to be constructed and operated electrically. 3800 w. Bul Int Ry Cong—Dec., 1907. No. 89509 E.

The Detroit River Tunnel. James C. Mills. Illustrated description of the construction of this tunnel under the Detroit River. 3500 w. Cassier's Mag—Jan., 1908. No. 89454 B.

The Flushing Tunnel for the Gowanus Canal in Brooklyn, N. Y. Illustrated detailed description of the construction of this tunnel, built to correct the unsanitary condition of the canal caused by sewerage and a variety of wastes. 3500 w. Eng Rec—Jan. 11, 1908. No. 89462.

Air Compressors on New York Tunnel Work. Frank Richards. An illustrated article giving information in regard to the great amount of tunnel work completed and in prospect in the vicinity of New York City, with details about the use of compressed air. 4000 w. Compressed Air—Jan., 1908. No. 89484.

Waterproofing.

Waterproof Engineering. Edward W. De Knight. Treats of methods and materials and their application. Ills. 6000 w. Jour Assn of Engng Socs—Dec., 1907. No. 89676 C.

MATERIALS OF CONSTRUCTION.

Brick.

The Sand-Lime Industry (Conference sur l'Industrie Silico-Calcaire). E. Leduc. A discussion of sand-lime brick, their composition, chemical reactions, manufacture, etc., describing leading plants for their manufacture in France. Ills. 8700 w. Bul Soc d'Encour—Nov., 1907. No. 89718 G.

Cement.

The Manufacture of Commercial Portland Cement. Richard K. Meade. Briefly describes the burning of raw material, the fuel used, the grinding of the clinker, etc. Ills. 2500 w. Min Sci—Jan. 23, 1908. No. 89851.

We supply copies of these articles. See page 1103.

Reinforced Concrete.

Tests of Bond Between Plain Bars and Concrete. L. R. Viterbo. A report of tests made at Washington University laboratory. 800 w. Engng-Con—Jan. 1, 1908. No. 89313.

See also same title, under CONSTRUCTION.

Steel.

See Columns, Latticing, and Plate Girders, under BRIDGES; and Steel, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Timber Preservation.

The Galesburg Timber Preserving Plant of the Burlington. Illustrated description of this large new plant embodying recent ideas. 1000 w. R R Gaz—Jan. 10, 1908. No. 89443.

The Seasoning and Preservative Treatment of Hemlock and Tamarack Cross-Ties. W. F. Sherfesee. Detailed account of experiments made to devise methods for bettering the treatment of these close-grained woods. Ills. 7000 w. U S Dept of Agri, Forest Serv—Circular 132. No. 89690 N.

The Estimation of Moisture in Creosoted Wood. Arthur L. Dean. Discusses the value of J. Marcusson's method for estimating the water and acid contents of lubricants, when applied to creosoted wood. Ills. 1200 w. U S Dept of Agri, Forest Serv—Circular 134. No. 89691 N.

See also Poles, under ELECTRICAL ENGINEERING, TRANSMISSION.

Waterproofing.

See same title, under CONSTRUCTION.

MEASUREMENT.

Concrete Testing.

The Analysis of Concrete. Royal L. Wales. Outlines work showing the writer's method of determining the ratio of cement to sand in mortar, and the ratio of mortar to rock, and the importance of such analyses. 1600 w. Eng News—Jan. 9, 1908. No. 89421.

Precipitation.

The Automatic Registration of Precipitation. James L. Bartlett. Illustrates and describes the instruments used by the United States Weather Bureau. 1200 w. Wis Engr—Dec., 1907. No. 89511 D.

Standardizing.

How Our Measures of Length Are Tested. Herbert T. Wade. Illustrates and describes the instruments employed and the methods. 2000 w. Sci Am—Feb. 1, 1908. No. 89930.

Stream Flow.

Theoretical Considerations on the Gauging of Streams with Changing Bottoms (Considérations Théoriques sur les Jaugeages des Cours d'Eau à Fond Mobile). M. R. Tavernier. Draws practical conclusions from theoretical considerations. Ills. 11000 w. Ann des Ponts et Chauss—1907—IV. No. 89711 E + F.

Surveying.

The Panoramic Camera Applied to Photo-Topographic Work. Charles Will Wright. An illustrated description of this method, discussing its advantages and accuracy. 4000 w. Bul Am Inst of Min Engrs—Jan., 1908. No. 89894 C.

The Alaskan Boundary Survey. Prof. O. M. Leland. Reviews the difficulties arising in regard to this boundary line, and gives an account of the controversy and its settlement, and the methods used in the final survey and marking of the line. Ills. 3500 w. Cornell Civ Engr—Jan., 1908. No. 89902 C.

MUNICIPAL.

Experiment Station.

Lawrence Experiment Station. A brief statement of the origin of the station and of the work done by the Mass. State Board of Health. Ills. 1500 w. Munic Jour and Engr—Jan. 15, 1908. No. 89537.

Garbage Disposal.

Destructor Plant for Chiswick Urban District Council. Illustrated description of a plant dealing not only with house-refuse, but with solids and sludge from sewage works. 900 w. Engng—Jan. 3, 1908. No. 89524 A.

Municipal Refuse Disposal: An Investigation. Discussion of the paper by J. T. Fetherston. 10000 w. Pro Am Soc of Civ Engrs—Jan., 1908. No. 89826 E.

Report on Garbage and Refuse Disposal, Milwaukee, Wis. A review of the report of Mr. Rudolph Hering, recently submitted to the city authorities. 3500 w. Eng News—Jan. 16, 1908. No. 89566.

The Importance of Garbage and Sewage Burning to the Electrical Industry (Ueber die Bedeutung der Müll- und Canalisationsschlammverbrennung für die Elektrotechnik). Discusses garbage and sewage destructors from a hygienic point of view and also their importance as sources of electric power. 3000 w. Elektrotech Rundschau—Dec. 24, 1907. No. 89746 D.

Germany.

Municipal Engineering in Germany. C. F. Wike. A summary of information including almost every branch of municipal work connected with sanitation. 6500 w. Surveyor—Jan. 10, 1908. No. 89638 A.

Pavements.

The Municipal Asphalt Pavement Repair-Plant at New Orleans. Information from a recent report by W. J. Hardee concerning the first year's work of this plant. Ills. 1500 w. Eng News—Jan. 2, 1908. No. 89272.

We supply copies of these articles. See page 1103.

A Municipal Repair Plant for Pavements, New Orleans, La. Plan and description of works and equipment, and reports of results. 2200 w. Eng Rec—Jan. 11, 1908. No. 89463.

Roads.

The Digging of Macadam Roads by Machinery (Note sur le Piochage Mécanique des Empierrements). M. Bret. Describes machines for breaking up macadam roads, giving costs. Ills. 10000 w. Ann des Ponts et Chauss—1907—IV. No. 89712 E + F.

The Destructive Effects of High-Speed Automobiles on Macadamized Roads (Effets Destructeurs des Grandes Vitesses Automobiles sur les Empierrements). M. Salle. Conclusions drawn after the recent *Grand Prix* trials of of the Automobile Club of France. Ills. 11000 w. Ann des Ponts et Chauss—1907—IV. No. 89709 E + F.

Septic Tanks.

The Cameron Septic Tank Patent Sustained by the Court of Appeals. Gives the full text of the decision and opinion of the U. S. Circuit Court of Appeals declaring the *process claims* of the Cameron septic tank patent are valid. Also editorial. 6500 w. Eng News. Jan. 23, 1908. No. 89806.

Sewage Disposal.

Notes on Sludge Disposal. George W. Fuller. Emphasizes the importance of good management in sewage-disposal plants, and of due attention to sludge disposal. 2500 w. Eng Rec—Jan. 18, 1908. No. 89610.

A Review of the Sewerage Problem of the City of Baltimore. Ezra B. Whitman. A brief account of the work being carried on to give the city a complete system of sanitary sewers and sewage disposal works. 4000 w. Cornell Civ Engr—Jan., 1908. No. 89904 C.

A Small Sewage Disposal Plant in Central Iowa. A. Marston. States the conditions often found in small towns of the middle west in the United States, and discusses how best to meet the difficulties. 1200 w. Cornell Civ Engr—Dec., 1907. No. 89689 C.

The Sewage Disposal System of Wilmersdorf (Die Entwässerungsanlagen der Gemeinde Wilmersdorf). Herr Müller. An illustrated description of the sewers, pumping plants, purification beds, etc., of this extensive system. Serial, 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Dec. 14, 1907. No. 89779 D.

See also Garbage Disposal and Septic Tanks, under MUNICIPAL.

Sewers.

The Completion of the Los Angeles, Cal., Outfall Sewer. Explains the conditions which made necessary a new outfall, and illustrates and describes its construction. 4000 w. Eng Rec—Jan. 25, 1908. No. 89829.

A Simple Formula for the Design of Drainage Canals (Eine einfache Formel für die Berechnung von Entwässerungskanälen). Fr. V. Meyer. A simplification of the Kutter formula. Serial, 1st part. 1100 w. Gesundheits-Ing—Dec. 21, 1907. No. 89768 D.

See also Sewage Disposal, under MUNICIPAL.

Smoke Prevention.

Smoke Prevention in Newark, N. J. Gives a new ordinance recently adopted, and describes improved methods of preventing smoke, especially the Thomas device. 1200 w. Eng Rec—Jan. 18, 1908. No. 89615.

Street Cleaning.

See San Francisco, under WATER SUPPLY.

WATER SUPPLY

Aqueducts.

See Edinburgh, under WATER SUPPLY.

Artesian Wells.

See Air Lift and Pumping, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Conduits.

Conduit of Special Design in Ogden, Utah. Describes a reinforced-concrete conduit, designed to meet special conditions. 1600 w. Eng Rec—Jan. 18, 1908. No. 89611.

Dams.

Final Report on the Award of the Ashokan Reservoir Dam Contract, New York City. Gives the final conclusions of the Commissioners of Accounts, with editorial comment. 3500 w. Eng News—Jan. 2, 1908. No. 89276.

A New Permanent and Movable Lath Dam (Nuova Diga Permanente Instabile a Panconcelli). Describes a movable dam of pine lath for use in emergencies at hydro-electric stations in Italy. 4000 w. Elettricita—Dec. 20, 1907. No. 89702 D.

See also Sluice Gates, under WATER SUPPLY; and Flood Protection, under WATERWAYS AND HARBORS.

Edinburgh.

The Talla Water Supply, Edinburgh, Scotland. Describes the reservoir and aqueduct which gives an additional supply of about 14,500,000 imp. gal. per day. 1700 w. Eng Rec—Jan. 4, 1908. No. 89359.

Faucets.

Faucets for Limiting Flow (Les Limitateurs de Débit). P. A. Bergès. Describes and illustrates faucets of German design which prevent waste by automat-

ically stopping unnecessary flow. Serial, 1st part. 3200 w. Génie Civil—Dec. 7, 1907. No. 89724 D.

Filtration.

Experiences in the Practical Operations of a Mechanical Filter Plant. C. H. Cobb. Abstract of a paper read before the Illinois Soc. of Engrs. & Survrs. 1000 w. Eng News—Jan. 30, 1908. No. 89924.

Fire Protection.

The New York City Fire-Protection Water System. Describes the high-pressure system designed to protect the dry-goods district. Ills. 3000 w. Eng Rec—Jan. 4, 1908. No. 89360.

Fire Prevention in High Buildings. The Need of Auxiliary Equipment. J. K. Freitag. A discussion of the Parker Building disaster in New York City, and its lessons. 3000 w. Engineering Magazine. Feb., 1908. No. 89878 B.

See also Hydrants and San Francisco, under WATER SUPPLY; and Fireproof, under CONSTRUCTION.

Great Britain.

Water Supply in 1907. Mainly a review of British progress and improvements. 3000 w. Engr, Lond—Jan. 3, 1908. No. 89529 A.

Hydrants.

Experiments on Various Types of Fire Hydrants. Charles L. Newcomb. Abridged from paper presented to the A. S. M. E. in 1899. An illustrated report of tests on types commonly used. Discussion. 17000 w. Jour N Eng W-Wks Assn—Dec., 1907. No. 89596 F.

Irrigation.

Irrigation in Egypt. Illustrates and describes the steam pumping plants which have been built during the last fifteen years for the purpose of irrigation in Egypt. 1500 w. Engr, Lond—Jan. 10, 1908. Serial. 1st part. No. 89658 A.

See also Nevada, under MINING AND METALLURGY, GOLD AND SILVER.

Orifices.

Discharge of Water from Minute Orifices. W. R. Baldwin-Wiseman. Describes experiments to determine the discharge at different pressures, from circular orifices of small diameter piercing pipes of moderate thickness. 1500 w. Surveyor—Jan. 10, 1908. No. 89639 A.

Pipe Corrosion.

See same title, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Pipe Flow.

Experiments with Submerged Tubes 4.0 Feet Square at the University of Wisconsin. Clinton B. Stewart. Abstract of a forthcoming bulletin on "An Investigation of Flow Through Large Submerged Orifices and Tubes." Ills. 6500 w. Wis Engr—Dec., 1907. No. 89510 D.

Research on the Discharge of Partly Filled Pipe Lines, Canals, Streams and Rivers (Ermittelung der Abflussmengen in Teilweise gefüllten Rohrleitungen, Kanälen, Bächen und Flüssen). Adolf Städing. A mathematical discussion of experimental results. Ills. Serial. 1st part. 5000 w. Gesundheits-Ing—Dec. 21, 1907. No. 89767 D.

Pipe Lines.

Note on the Determination of the Most Efficient and Satisfactory Pipe Diameter for Water-Works Pipe Lines (Beitrag zur Berechnung der wirtschaftlich günstigsten Rohrdurchmesser bei Pumpwerks-Wasserleitungen). Joh. Pelinka. A mathematical discussion. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Dec. 20, 1907. No. 89752 D.

Pipe Specifications.

Cast-Iron Pipe Specifications. William R. Conard. Aims to show what may be done. General discussion. 3000 w. Jour N Eng W-Wks Assn—Dec., 1907. No. 89595 F.

Pipe Testing.

The Testing of Pipes by Outward Pressure (Die Prüfung von Rohren auf äusseren Ueberdruck). E. Preuss. A review of the methods used, and formulae developed, by various investigators. Ills. 2800 w. Stahl u Eisen—Dec. 18, 1907. No. 89735 D.

Purification.

The Sterilization of Water by Electricity (Esterilizacion Eléctrica de las Aguas). Eduardo Gallego. Illustrates and describes small household devices in the first instalment. Serial. 1st part. 2000 w. Energia Elec—Dec. 10, 1907. No. 89705 D.

See also Filtration and Reservoirs, under WATER SUPPLY; and Boiler Waters, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Reservoirs.

The Croton Falls Reservoir, Croton Water System, New York. Illustrated description of one of a series of reservoirs now being completed to increase the water supply. 3000 w. Eng Rec—Jan. 18, 1908. No. 89608.

Recent Improvements to the Water-Works at Peabody, Mass., Including Pumping Plant and Distributing Reservoir. Frank A. Barbour. Gives a brief history of the works and describes the new pumping plant and reservoir. Ills. 4400 w. Jour N Eng W-Wks Assn—Dec., 1907. No. 89594 F.

The Waltham Reservoir. Bertram Brewer. Gives an illustrated detailed description of the construction of this large reinforced-concrete standpipe. Also discussion. 7500 w. Jour N Eng W-Wks Assn—Dec., 1907. No. 89593 F.

We supply copies of these articles. See page 1103.

The Construction of a Masonry Reservoir with a Capacity of 22,000 Cubic Meters for the Water Supply System of Dinan (Notice sur la Construction d'un Réservoir en Maçonnerie de 22,000 Mètres Cubes destiné à l'Alimentation de la Ville de Dinan). M. Daubert. Ills. 4000 w. Ann des Ponts et Chauss—1907—IV. No. 89713 E + F.

The Reservoir with Iron-Removal Plant of the Plauen Curtain Manufacturing Company at Plauen (Das Hochreservoir mit Enteisenungsanlage der Gardinenfabrik Plauen Act.-Ges. in Plauen im Vogtlande). Max Sieb. A reservoir for the purification of bleaching water is illustrated and described, the first part of the serial giving a mathematical discussion of the design. Serial. 1st part. 6000 w. Beton u Eisen—Dec., 1907. No. 89776 F.

See also Edinburgh, under WATER SUPPLY.

San Francisco.

Proposed Auxiliary Water System for Fire Protection and Flushing Purposes, San Francisco, Cal. Gives an outline of a proposed scheme at an estimated cost of $5,500,000. 900 w. Eng News—Jan. 16, 1908. No. 89574.

Sluice Gates.

Electrically Operated Sluice Gates for the Shoshone and Pathfinder Dams. F. W. Hanna. Illustrated description of high-pressure gates for the control of dams remarkable for the high heads under which they are to be operated. 2700 w. Eng News—Jan. 2, 1908. No. 89273.

Stream Flow.

Stream Flow Data from a Water-Power Standpoint. Charles E. Chandler. Gives tabulated data with methods of analyzing river discharges. General discussion. 6500 w. Jour N Eng W-Wks Assn—Dec., 1907. No. 89597 F.

Stream Gauging.

See Stream Flow, under MEASUREMENT.

Valuation.

The Appraisal and Depreciation of Water-Works and Similar Properties. William H. Bryan. States eleven methods that may be used, briefly considering their merits; outlines methods of computing depreciation, etc. General discussion. 16000 w. Jour Assn of Engng Socs—Dec., 1907. No. 89677 C.

WATERWAYS AND HARBORS.

Barge Canal.

Report on the New York Barge Canal Work by the Superintendent of Public Works. Abstract of the annual report of Hon. Frederick C. Stevens favoring the Federal Deep Waterway. 2500 w. Eng News—Jan. 23, 1908. No. 89808.

British Harbors.

Harbors and Waterways in 1907. Principally a review of improvements at British ports, but briefly considering United States waterways and foreign ports. 6500 w. Engr, Lond—Jan. 3, 1908. No. 89527 A.

Canals.

The Teltow Canal. Map and illustrated description of this German canal, constructed chiefly to overcome difficulties in draining Berlin suburban districts. 1800 w. Engr, Lond—Dec. 27, 1907. No. 89392 A.

See also Barge Canal and Panama Canal, under WATERWAYS AND HARBORS.

Chicago.

Chicago Harbor and Water-Front Park Improvement Question. Gives Mayor Busse's message to the city council protesting against devoting the whole of the water front to parks, urging improvements in harbor facilities. Map and editorial. 3300 w. Eng News—Jan. 23, 1908. No. 89809.

Docks.

The Steel Ore Dock at Narvik, Norway. John Birkinbine. Explains the terms of the Swedish Government ore contract, and illustrates and describes the facilities at Narvik for exporting the iron ore. 2500 w. Ir Age—Jan. 9, 1908. No. 89412.

See also Harbors, under WATERWAYS AND HARBORS.

Dredging.

Dredging Costs on the St. Lawrence River and in Other Parts of Canada. Emile Low. Brief account of work with tabulated statement of cost during fiscal year 1905-06. 1700 w. Eng News—Jan. 30, 1908. No. 89921.

See also Dredges, under MARINE AND NAVAL ENGINEERING.

Flood Protection.

The Building of the Friedrichswald Valley Barrier and Its First Year's Operation (Ueber den Bau der Friedrichswalder Talsperre und Bericht über das erste Betriebsjahr). Viktor Czehak. A description of a large dam and other flood protection works in this district in Austria. Ills. Serial, 1st part. 2700 w. Zeitschr d Oest Ing u Arch Ver—Dec. 6, 1907. No. 89749 D.

Florida.

The Coast and Inland Waters of Florida. M. B. Claussen. Illustrated description of the picturesque inland route from one end of Florida to the other, through rivers, bayous, sounds and connecting canals. 4500 w. Rudder—Jan., 1908. No. 89394 C.

Harbors.

The Physical Difficulties of Modern Harbor and Dock Extension. H. C. M. Austen. Discusses some of the financial and physical difficulties in connection with

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preparing docks and harbors for vessels of ever-increasing size. 1600 w. Engng—Jan. 10, 1908. No. 89654 A.

See also British Harbors, Chicago, Italian Harbors, Rangoon, and St. John, N. B., under WATERWAYS AND HARBORS.

Italian Harbors.

Navigation in Italian Harbors in the Years 1904-1905 (La Navigazione nei Porti Italiani negli Anni 1904-1905). Antonio Tess. A statistical review of increasing commerce. Ills. 14000 w. Rivista Marittima—Dec., 1907. No. 89700 E + F.

Locks.

Construction and Unit Costs of Concrete Lock, Rough River, Kentucky. Compiled from the Annual Report of the Chief of Engineers, U. S. Army. Ills. 2000 w. Eng News—Jan. 9, 1908. No. 89420.

See also Mechanical Locks, under WATERWAYS AND HARBORS.

Mechanical Locks.

The Oelhafen-Löhle Ship Lift (Das Schiffshebewerk, System "Oelhafen-Löhle"). K. E. Hilgard. Illustrated description. 2500 w. Deutsche Bau—Dec. 14, 1907. No. 89745 B.

The Efficiency of Ship Lifts (Die Wirtschaftlichkeit von Schiffshebewerken). Hermann Bertschinger. A thorough discussion of their design and the advantages and disadvantages of their operating features. Ills. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—Dec. 1, 1907. No. 89778 D.

Panama Canal.

At Panama. Fullerton L. Waldo. Illustrates and describes the work as viewed by the writer, giving information concerning life on the isthmus, progress of work, etc. 4500 w. Jour Fr Inst—Jan., 1908. No. 89554 D.

Statement of Col. George W. Goethals, Chairman of the Isthmian Canal Commission, before the Senate Committee on Interoceanic Canals. Interesting extracts from the testimony. 6500 w. Eng News—Jan. 30, 1908. No. 89923.

The Culebra Cut of the Panama Canal. A. S. Zinn. Briefly outlines the history of the project, and gives an illustrated description of the nature of the country and general conditions, the work that has been accomplished, the equipment, etc. 5500 w. Jour W Soc of Engrs—Dec., 1907. No. 89552 D.

Rangoon.

New Port Works at Rangoon. Describes previous conditions at this port of India, and describes the new works. 1200 w. Engr, Lond—Jan. 17, 1908. No. 89873 A.

St. John, N. B.

Schemes Showing the Possibilities of St. John, N. B., as a Great Port; and How the Interior of New Brunswick Can Be Opened Up to Ocean Traffic. J. S. Armstrong. Also notes and amendments. Maps. 8500 w. Can Soc of Civ Engrs—1907. No. 89602 N.

Wharves.

See Viaducts, under BRIDGES.

MISCELLANY.

Review of 1907.

Engineering in the United States in 1907. Railways, tramways, bridges, tunnels, canals, and harbors are considered in the present number. 4000 w. Engr, Lond—Jan. 10, 1908. Serial. 1st part. No. 89656 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

Land Wireless Telegraphy. Major Edgar Russell. Reviews the work of the U. S. Signal Corps in this field, describes stations established and their equipment, modern field telegraphs, etc. Ills. 8000 w. Jour U S Art—Nov., 1907. No. 89502 D.

Electrical Oscillations on Helices. C. J. Watson. Brief explanation of methods used in investigating and the results. 300 w. Elect'n, Lond—Jan. 3, 1908. No. 89517 A.

On Magnetic Oscillators as Radiators in Wireless Telegraphy. J. A. Fleming. Considers the closed, or magnetic, type of oscillator. 2800 w. Elect'n, Lond—Dec. 27, 1907. Serial. 1st part. No. 89379 A.

Telephone Tolls.

The Determination of Telephone Rates for Large Exchanges. William H. Crumb. Points out some of the questions that must be given consideration in order to establish equitable rates for large telephone exchanges. Discussion. 10500 w. Jour W Soc of Engrs—Dec., 1907. No. 89550 D.

DISTRIBUTION.

Potential Regulator.

The Tirrill Automatic Potential Regulator (Ueber den selbsttätigen Spannungsregler System Tirrill). Dr. Gustav Grossmann. Illustrated description with details of operation. Serial. 1st part. 2000 w. Elektrotech Zeitschr—Dec. 12, 1907. No. 89786 D.

We supply copies of these articles. See page 1103.

Regulations.
See same title, under TRANSMISSION.

Wiring.
Interior Wiring Progress in the Rocky Mountain Districts. W. J. Canada. Gives a summary of the conditions in the region as viewed from the insurance inspection standpoint. 2500 w. Elec Wld—Feb. 1, 1908. No. 89913.

Wiring of Residences at Small Cost. Thomas W. Poppe. Explains how a dwelling can be wired at small cost without damage to walls, decorations or floors. 2000 w. Elec Wld—Jan. 4, 1908. No. 89418.

DYNAMOS AND MOTORS.

A. C. Dynamos.
Test of a Low-Voltage Alternator for Calcium Carbide Furnaces. A report of tests made of an alternator for calcium carbide works in Ireland. 1000 w. Elec Rev, Lond—Jan. 17, 1908. No. 89867 A.

The Non-Synchronous Generator in Central Station and Other Work. W. L. Waters. Considers the general characteristics of the non-synchronous generator, its excitation; showing it to be superior to the synchronous generator for supplying power to motor-generators and synchronous converters through an underground cable system, and other applications, especially in connection with turbine-driven generators. 8500 w. Pro Am Inst of Elec Engrs—Feb., 1908. No. 89896 D.

Theoretical and Practical Notes on the Parallel Operation of Alternating-Current Machines (Theoretisches und Praktisches über den Parallelbetrieb von Wechselstrommaschinen). Gustav Benischke. Ills. 2800 w. Elektrotech u Maschinenbau—Dec. 29, 1907. No. 89748 D.

A. C. Motors.
The Torque Conditions in Alternate Current Motors. Val. A. Fynn. Deals with torque conditions in types of single and polyphase commutator and squirrel-cage or slip-ring motors, comparing their relative weight efficiencies. Diagrams. 13500 w. Inst of Elec Engrs—1907. No. 89670 N.

Ball-Bearings.
See same title, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

D. C. Dynamos.
The Unipolar Dynamo. E. J. Noe. A brief description of the electrical operation of these machines. Ills. 2000 w. Wis Engr—Dec., 1907. No. 89512 D.

The Early Days of the Dynamo. Sydney F. Walker. Gives a résumé of the early history of the development of this machine. 3000 w. Elec Rev, N Y—Jan. 11, 1908. No. 89471.

Induction Motors.
Magnetic Leakage in Induction Motors. R. E. Hellmund. A discussion of the factors which influence the leakage coefficient without causing an appreciable change in the main flux of the motor. 3000 w. Elec Wld—Jan. 25, 1908. No. 89822.

Insulation.
Cellulose Acetate as Wire Insulation. R. Fleming. Extracts from an article in the *Gen. Elec. Rev.* Gives a comparison with silk and cotton insulation. 700 w. Eng News—Jan. 16, 1908. No. 89568.

Railway Motors.
A Single-Phase Railway Motor. E. F. Alexanderson. Describes a "series repulsion motor," and its operation, stating the advantages claimed. Diagrams. 4500 w. Pro Am Inst of Elec Engrs—Jan., 1908. No. 89326 D.

Repulsion Motors.
Control of Repulsion Motors by Brush Displacement. K. Schnetzler. From *Elektrotech. Zeitschr.* Considers how far this method of regulation may be regarded as satisfactory. 1700 w. Elect'n, Lond—Jan. 3, 1908. No. 89518 A.

Single Phase.
See Railway Motors, under DYNAMOS AND MOTORS.

ELECTRO-CHEMISTRY.

Electrolytic Assaying.
See Assaying, under MINING AND METALLURGY, COPPER.

Electro-Metallurgy.
See same title, under MINING AND METALLURGY, IRON AND STEEL; and Lead Refining, under MINING AND METALLURGY, LEAD AND ZINC.

Electro-Plating.
A Study of the Causes of Impure Nickel Plate with Special Reference to the Iron. D. F. Calhane and A. L. Gammage. Describes experiments made to ascertain the amount of iron present, and to study the conditions that influence its deposition. 2500 w. Jour Worcester Poly Inst—Jan., 1908. No. 89697 C.

ELECTRO-PHYSICS.

Alternating Currents.
A Plea for the Physical Treatment of Alternating-Current Phenomena. Lamar Lyndon. Shows how alternating-current phenomena may be explained and made as simple as continuous-Current. Also editorial. 2500 w. Elec Rev, N Y—Jan. 11, 1908. No. 89472.

Demagnetization.
On the Best Method of Demagnetizing Iron in Magnetic Testing. Charles W. Burrows. Outlines a plan whereby a specimen may be freed from all effects of previous magnetic treatment and so be

We supply copies of these articles. See page 1103.

brought to a standard condition. 12500 w. Bul Bureau of Stand—Jan., 1908. No. 89692 N.

Magnetic Alloy.

Heusler's Magnetic Alloy. A. D. Ross. Slightly abridged paper read before the Roy. Soc. of Edinburgh. An account of tests carried out. 1000 w. Elect'n, Lond —Dec. 27, 1907. No. 89380 A.

Solenoids.

Solenoids in Series with Resistance. Charles R. Underhill. Considers the resistance in the circuit external to the resistance of the winding. 1500 w. Elec Wld—Jan. 18, 1908. No. 89625.

GENERATING STATIONS.

Central Stations.

New Turbine Station of the Fall River Electric Light Company. Illustrated detailed description. 1800 w. Elec Wld—Jan. 25, 1908. No. 89821.

The Cos Cob Power Plant of the New York, New Haven & Hartford Railroad. E. H. Coster. Illustrated detailed description of the plant supplying power for the division between New York and Stamford. 5000 w. Elec Jour—Jan., 1908. No. 89678.

The Northern Colorado Power Company. N. A. Carle. Brief illustrated description of a steam-power plant located in the coal fields at Lafayette, and distributing current by 80 miles of transmission lines. 1500 w. Min Sci—Jan. 9, 1908. No. 89492.

Plant of the Terre Haute (Ind.) Traction & Light Co. Illustrated description of a new turbine plant with high-tension transmission for interurban railway service and mercury arc rectifier for street lighting. 4000 w. Engr, U S A—Jan. 15, 1908. No. 89590 C.

The Condition and Development of the Mainz City Electric Plant (Die Beschaffenheit und Entwicklung des städtischen Elektrizitätswerkes Mainz). Herr Furkel. An illustrated description of this municipal plant. Serial. 1st part. 1200 w. Elektrotech Zeitschr—Dec. 5, 1907. No. 89783 D.

See also Gas Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Compensators.

See Voltage Drop, under TRANSMISSION.

Design.

Management and Efficiency of the Designing Department, and Its Bearing Upon the First Cost and Economy in Operation of Steam-Electric Power Plants. Frank Koester. 2200 w. Elec Rev, N Y—Jan. 18, 1908. No. 89931.

Hydro-Electric.

Hydro-Electric Power at Duluth. Dwight E. Woodbridge. Illustrates and describes the Great Northern Power Company's developments. 4000 w. Ir Age—Jan. 2, 1908. No. 89290.

Power Development of the Kootenay River for the West Kootenay Power and Light Company, Limited. Robert A. Ross and Henry Holgate. Illustrated description of power development at Upper Bonnington Falls. 3000 w. B C Min Rec—Nov, 1907. No. 89698 B.

Recent Power Developments at Montpelier, Vt. Illustrated description of the high-tension systems of two companies furnishing current for lighting and power. Gives data of a test made upon motors used in a granite shed, at Barre, Vt. 3000 w. Elec Wld—Jan. 4, 1908. No. 89423.

The Augst-Wylen Water-Power Plant (Die Wasserkraftanlage Augst-Wylen). Illustrated description of this plant on the Rhine near Basle, Switzerland. 2500 w. Schweiz Bau—Dec. 14, 1907. No. 89744 B.

The Hohenfurth Electric Plant (Das Elektrizitätswerk Hohenfurth). P. Ehrlich. An illustrated description of this plant in Austria on the Moldau. 2300 w. Zeitschr d Oest Ing u Arch Ver—Dec. 27, 1907. No. 89753 D.

See also High Tension, under TRANSMISSION; and Turbine Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Isolated Plants.

The Turbine Plant for the Shops of the Technical High School at Charlottenburg (Die Dampfturbinenanlage des Maschinenbaulaboratoriums der kgl. Technischen Hochschule Charlottenburg). E. Josse. Illustrated detailed description of a plant for generating electric power for use in the extensive laboratories and shops of this institution. Serial. 1st part. 2500 w. Zeitschr f d Gesamte Turbinenwesen —Dec. 10, 1907. No. 89773 D.

See also Mechanical Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Operation.

The Operation of a Small Electric Plant. W. H. Wakeman. Suggestions in regard to motors and lamps. Ills. 2500 w. Elec Wld—Feb. 1, 1908. No. 89917.

Noisy Operation of Dynamos. Nathaniel R. Craighill. Shows how to determine whether a machine will run noisy, and how to remedy the trouble. 700 w. Elec Wld—Feb. 1, 1908. No. 89916.

Convenient Tests for Central Station Operators. W. M. Hollis. Outlines methods for measuring insulation resistance for locating grounds, etc. 1200 w. Elec Wld—Feb. 1, 1908. No. 89915.

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Rates.

Rates and Systems of Charging. Discusses systems of charging in England and gives the writer's idea of an ideal rate. 1800 w. Elec Rev, Lond—Dec. 27, 1907. No. 89375 A.

Switchboards.

See same title, under TRANSMISSION.

LIGHTING.

Arc Lamps.

The New Type of Arc Lamp (Nouveau Type de Lampe à Arc). H. Guérin. Discusses the Bremer, Siemens and Blondel types of metallic electrode arc lamps giving photometric results. Ills. 3000 w. Génie Civil—Dec. 7, 1907. No. 89725 D.

Illumination.

Distribution of Light. Otto Foell. Read before the Ill. Engng. Soc. Shows what an ideal distribution curve should be, and what can be accomplished with a proper light distribution. 2200 w. Elec Rev, N Y—Jan. 4, 1908. No. 89338.

General Office Building of the Philadelphia Electric Company. Illustrated description of the building and its equipment, especially the lighting. 2800 w. Elec Wld—Jan. 11, 1908. No. 89481.

Lighting of the New Plaza Hotel. H. Thurston Owens. An illustrated detailed description of the lighting installation of a hotel costing nearly $13,000,000. 2000 w. Elec Wld—Jan. 4, 1908. No. 89416.

Artistic Illumination—Murray's Restaurant, New York City. H. Thurston Owens. Illustrated description of an elaborately lighted restaurant. 1400 w. Elec Wld—Feb. 1, 1908. No. 89912.

Incandescent Lamps.

Manufacture of Incandescent Lamps. George Loring. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Describes the process in detail. 1800 w. Engr, U S A—Jan. 15, 1908. No. 89592 C.

Some Facts Regarding Metal-Filament and Carbon-Filament Lamps. George Loring. Shows comparative results of carbon, tantalum, and tungsten filament lamps, and advantage of substituting metal-filament for carbon-filament lamps. 1200 w. Elec Wld—Jan. 4, 1908. No. 89417.

Photometry.

The Utilization of Photometric Data. William E. Wickenden. An explanation of the principles, methods and tables by which such data may be made useful. 1500 w. Wis Engr—Dec., 1907. No. 89513 D.

A New Universal Photometer. Clayton H. Sharp and Preston S. Millar. Illustrates and describes an instrument designed by the writers, and its performance. 2200 w. Elec Wld—Jan. 25, 1908. No. 89823.

Street.

Street Lighting in 1907. Alton D. Adams. A review of progress in England and America. 3000 w. Munic Jour & Engr—Jan. 1, 1907. No. 89298.

Street Lighting and New Illuminants. Dr. Louis Bell. Remarks on the gain in efficiency and related subjects. 1700 w. Elec Wld—Jan. 11, 1908. No. 89483.

MEASUREMENT.

Cable Testing.

See Cables, under TRANSMISSION.

Galvanometer.

Direct-Reading Galvanometer Scales. J. Rymer-Jones. Gives a method which saves time and calculation. 1000 w. Elec Rev, Lond—Jan. 10, 1908. No. 89645 A.

Instruments.

A New Recording Electrical Voltmeter and Ammeter of Great Sensitiveness and Accuracy. Illustrated description of a milli-voltmeter recently devised by Prof. Wm. H. Bristol. 600 w. Eng News—Jan. 2, 1908. No. 89274.

Instrument Testing.

See Potentiometer, under MEASUREMENT.

Potentiometer.

A Deflection Potentiometer for Voltmeter Testing. Shows what features should be incorporated in an instrument of this kind for such work as the testing of voltmeters, and describes a type of instrument recently constructed. 6500 w. Bul Bureau of Stand—Jan., 1908. No. 89693 N.

Reactance.

See same title, under TRANSMISSION.

Resistance.

On the Comparison of Resistances. F. E. Smith. Critical discussion of the universal slide wire bridge devised by Dr. Drysdale, and the corrections necessary where great accuracy is required. Also brief communication from Dr. C. V. Drysdale. 3000 w. Elect'n, Lond—Jan. 10, 1908. No. 89647 A.

Wattmeters.

The Design of Prepayment Watt-Hour Meters. Arthur Pestel. Considers the more important points involved, indicating the way the difficulties may be overcome. Diagrams. 2500 w. Elec Wld—Jan. 18, 1908. No. 89624.

TRANSMISSION.

Cable Heating.

See Wire Heating, under TRANSMISSION.

Cables.

High-Tension Cables and Their Testing (Ueber Hochspannungs-Kabel und ihre Prüfung). C. Feldmann and J. Herzog. Discusses cable sections, dielectric materials, testing methods, etc. Ills.

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2000 w. Elektrotech Zeitschr—Dec. 5, 1907. No. 89782 D.

See also Insulation, under TRANSMISSION.

Conduits.

Municipal Conduit System of the City of Baltimore, Md. Illustrated description. 2000 w. Elec Wld—Jan. 4, 1908. No. 89415.

Fault Finding.

The Earth-Potential Method of Fault Finding. W. A. Toppin. Shows how this method may be applied on three-wire networks, two-wire networks, D. C. or A. C., and traction feeders, provided that current can be passed through the faulty cable to earth. 500 w. Elec Rev, Lond—Jan. 3, 1908. No. 89516 A.

Four-Wire.

Four-Wire Distribution. Harold H. Jowers. Brief explanation of the advantages claimed for this system. 600 w. Elec Rev, Lond—Dec. 27, 1907. No. 89376 A.

High-Tension.

High-Tension Energy Transmission in Peru. An illustrated description of the stations and their equipment, the lines and of some of the difficulties. 1800 w. Elec Wld—Feb. 1, 1908. No. 89911.

Discussion on High-Tension Transmission Papers, at Niagara Falls, N. Y., June 26, 1907. 5000 w. Pro Am Inst of Elec Engrs—Feb., 1908. No. 89900 D.

Inductance.

The Self and Mutual Inductances of Linear Conductors. Edward B. Rosa. A discussion of the formulæ used, with the derivation of new expressions, and illustrated by examples. 6500 w. Bul Bureau of Stand—Jan., 1908. No. 89694 N.

Insulation.

The Dielectric Strength of Insulating Materials and the Grading of Cables. Alexander Russell. Discusses the laws of disruptive discharge, the methods of measuring the dielectric strengths of gases, liquids, and solids, and the electric stresses on the insulating materials of a single-core cable, with special reference to the grading of cables. 7800 w. Inst of Elec Engrs—Nov. 14, 1908. No. 89859 N.

Insulators.

High Voltage Insulator Manufacture. Walter T. Goddard. An illustrated article describing the process of manufacture, testing, etc., and discussing materials, design, and related matters. 5500 w. Can Soc of Civ Engrs—Dec. 19, 1907. No. 89603 N.

High Tension Insulators from an Engineering and Commercial Standpoint. C. E. Delafield. Read before the Can. Elec. Assn. Briefly considers the present requirements of high tension transmission, discussing the design of porcelain insulators, their manufacture and testing. 3300 w. Can Elec News—Jan., 1908. No. 89605.

Lines.

See High-Tension, under TRANSMISSION.

Poles.

The Life and Efficiency of Wooden Poles in Austria (Lebensdauer und Gebrauchswert hölzerner Leitungsmaste in Oesterreich). Robert Nowotny. The experience of the State Telegraph Department with natural and treated poles. Ills. 3500 w. Elektrotech u Maschinenbau—Dec. 1, 1907. No. 89747 D.

Protective Devices.

The Application of Protective Devices to Trolley Lines (Application des Appareils de Protection aux Lignes de Trolley). M. Mariage. A discussion of trolley accidents and a description and comparison of the leading types of protective devices. Ills. 4200 w. Bul Soc Int d'Elec'ns—Dec., 1907. No. 89708 F.

Appliances for Guarding against the Consequences of Ruptures of Overhead Wires (Appareils de Protection contre les Conséquences des Ruptures des Conducteurs Aériens). M. Barré. An illustrated description of various types of suspension devices which automatically break the circuit in case of accident. 4000 w. Bul Soc Int d'Elec'ns—Dec., 1907. No. 89707 F.

Protective Relays.

Protective Relays. M. C. Rypinski. Considers the various classes and the conditions under which they operate. Ills. 2500 w. Elec Jour—Jan., 1908. Serial, 1st part. No. 89581.

Reactance.

The Slide Rule in the Calculation of Magnetic Reactance. M. S. Howard. Gives a slide-rule method for calculating the reactance of alternating-current transmission lines. 1000 w. Elec Wld—Jan. 18, 1908. No. 89626.

Regulations.

Rules Issued by the Verband Deutscher Elektrotechniker for Overhead Wires, Cables, and Electric Wiring. Gives the revised rules that come into force Jan. 1, 1908. 2800 w. Elect'n, Lond—Dec. 27, 1907. No. 89377 A.

Rotary Converters.

Some Developments in Synchronous Converters. Charles W. Stone. Points out some of the more important improvements made in the last few years. Ills. 2500 w. Pro Am Inst of Elec Engrs—Feb., 1908. No. 89897 D.

Some Features of Railway Converter Design and Operation. J. E. Woodbridge. Considers six-phase versus three-phase converters; the alternating-current starting of synchronous converters; and

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the compounding of converters. Ills. 6500 w. Pro Am Inst of Elec Engrs—Feb., 1908. No. 89898 D.

See also A. C. Dynamos, under DYNAMOS AND MOTORS.

Switchboards.

Electrically Operated Switchboards. S. Q. Hayes. Deals with the panels, desks, pedestals, etc., illustrating and describing both recent and older equipments, to show the progress. 3000 w. Elec Wld—Feb. 1, 1908. No. 89914.

Three-Phase.

See Voltage Drop, under TRANSMISSION.

Voltage Drop.

Voltmeter Compensation for Drop in Alternating-Current Feeder Circuits. William Nesbit. Considers methods, describing types of compensators and discussing their adjustment. 3500 w. Elec Jour—Jan., 1908. No. 89680.

Inductive Voltage Drop on Three-Phase Transmission, with the Conductors Lying in the Same Plane. Alfred Still. Explains a practical method of calculating the inductive effects when the conductors are arranged in line at a stated distance. 1600 w. Elec Engr, Lond—Jan. 10, 1908. No. 89644 A.

Wire Heating.

Temperature Rise of Conductors. C. C. Badeau. Gives a chart showing the relation between temperature rise and current. Also editorial. 1200 w. Elec Wld—Jan. 11, 1908. No. 89482.

Wire Suspension.

Pringle's Tangential System of Supporting Overhead Trolley Wires. Illustrated description of a system in which each suspension is made by a wire attached to two ears a considerable distance apart. 3500 w. Elect'n, Lond—Jan. 10, 1908. No. 89648 A.

See also Protective Devices, under TRANSMISSION.

MISCELLANY.

Government Ownership.

State Control of Electricity Supply in Germany. Editorial discussion of the proposal to make electricity supply in Germany a monopoly of the Imperial treasury. 1000 w. Engng—Jan. 10, 1908. No. 89798 A.

Review of 1907.

The Electrical Industries in 1907. A brief review of the important developments of the past year. 3500 w. Elec Rev, N Y—Jan. 11, 1908. No. 89470.

Varnishes.

Heat-Dissipating Varnishes. A. R. Warnes. Brief notes on their composition and heat-dissipating properties. 1200 w. Elec Rev, Lond—Jan. 17, 1908. No. 89866 A.

INDUSTRIAL ECONOMY

Apprenticeship.

Grand Trunk Apprentice System. Information concerning the entrance requirements, training, wages, etc. Ills. 2500 w. Am Engr & R R Jour—Jan., 1908. No. 89318 C.

The Training of Engineering Apprentices. Commences a general review of the methods of training employed by various firms. Ills. 3500 w. Engr, Lond—Jan. 17, 1908. Serial, 1st part. No. 89871 A.

Copper Trade.

See Trade, under MINING AND METALLURGY, COPPER.

Cost Keeping.

A Simple System of Recording Shop Costs. C. J. Redding. Outlines a system used successfully in an English works employing three thousand men. The use of a "shop summary" card is explained. 4500 w. Engineering Magazine—Feb., 1908. No. 89881 B.

Depreciation.

See Valuation, under CIVIL ENGINEERING, WATER SUPPLY.

Education.

A Plea for the Broader Education of the Chemical Engineer. Address by Clifford Richardson before the American Assn. for the Advancement of Science. 5500 w. Eng Rec—Jan. 4, 1908. No. 89358.

The Education of Young Men for Mechanical Pursuits. R. T. Crane, Sr. An explanation of the writer's views on manual training, technical education, trade schools, and training of apprentices. General discussion. 18700 w. Pro W Ry Club—Dec. 17, 1907. No. 89546 C.

The Relations of Technical Education to Industry. Charles Buxton Going. A criticism of the preparation given in technical schools, with suggestions for bringing it more in harmony with practical industry. 3000 w. Columbia Univ Qr—Dec., 1907. No. 89543 D.

The Best Engineering Education. Charles F. Scott. Introduction to a digest of previous papers on engineering education, with a view to renewing discussion. 4500 w. Pro Am Inst of Elec Engrs—Jan., 1908. No. 89328 D.

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Electrical Engineering Education. Charles P. Steinmetz. A criticism of some defects. 2500 w. Pro Am Inst of Elec Engrs—Jan., 1908. No. 89329 D.

The Place of the Laboratory in the Training of Engineers. A. L. Mellanby. Discusses the general course of training for engineers, particularly laboratory work in the colleges of the United Kingdom. Ills. 3000 w. Inst of Engrs & Shipbldrs in Scotland—Nov. 19, 1907. No. 89861 N.

Laboratory Instruction in Testing Materials. Edgar Marburg. A summary of the methods adopted in the Engineering Department of the University of Pennsylvania. 2000 w. Cement Age—Jan., 1908. No. 89685 C.

Higher Education in South America. William R. Shepherd. An account of the universities and institutions for higher education and matters relating to them. 2200 w. Columbia Univ Qr—Dec., 1907. No. 89545 D.

History of the Engineering Schools of Columbia University. A series of articles by C. F. Chandler, William H. Burr, Ira H. Woolson, Francis B. Crocker, and Charles Edward Lucke, reviewing the history of the various departments. Ills. 11000 w. Columbia Univ Qr—Dec., 1907. No. 89544 D.

See also Apprenticeship, under INDUSTRIAL ECONOMY.

Eight-Hour Day.

The Reduction of the Working Day to Eight Hours (La Réduction de la Journée de Travail à Huit Heures). Maurice Alfassa. A long discussion of the experiences with the system in French industries and also in other parts of the world. 25000 w. Bul Soc d'Encour—Nov., 1907. No. 89719 G.

Employer's Liability.

The Dire Cost and Best Remedy for Carelessness. Thomas D. West. Read before the Philadelphia Found. Assn. Discusses the subject of accidents due to carelessness, and the best remedy. 3000 w. Ir Age—Jan. 9, 1908. No. 89414.

Industrial Museums.

A New Engineering Museum in Berlin, Germany. Bruno Braunsburger. An illustrated account of this recent addition to Germany's educational institutions, and the exhibits. 1800 w. Eng News—Jan. 9, 1908. No. 89419.

Inventory.

Taking an Inventory. Sterling H. Bunnell. Describes a method of taking a careful shop inventory. 2000 w. Eng News—Jan. 2, 1908. No. 89275.

Iron Trade.

See Trade, under MINING AND METALLURGY, IRON AND STEEL.

Labor.

Trades Unions, Trusts, Employers' Associations (Arbeitsnehmerverbände, Kartelle, Arbeitgeberverbände). Leo Vossen. A discussion of the labor question in German. 2800 w. Stahl u Eisen—Dec. 4, 1907. No. 89733 D.

Pension System.

A Modern System of Pensioning and Insuring Employes. Gives an outline of the system of benefits put into effect by Deere & Co., Moline, Ill. 1500 w. Ir Trd Rev—Jan. 23, 1908. No. 89820.

Purchasing.

A Systematized Purchasing Department. Explains a method for handling buying records, devised by T. P. Artaud, purchasing agent for the Hudson Companies of New York. 2500 w. Ir Age—Jan. 23, 1908. No. 89699.

Shop Management.

See Management, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Stores Keeping.

See Inventory, under INDUSTRIAL ECONOMY; and Locomotive Maintenance, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Wages.

See same title, under MINING.

MARINE AND NAVAL ENGINEERING

British Navy.

The Naval Situation. Editorial review of the present condition of the Navy, the vessels built in 1907, and the performance of the vessels. Gives results of steam trials of armored ships during the year. 3000 w. Engng—Jan. 3, 1908. No. 89533 A.

Cable Ship.

A New Cable Ship. Illustrated detailed description of the "Guardian," built in England for an American Company. 1500 w. Engr, Lond—Jan. 3, 1908. No. 89528 A.

Destroyer.

Boilers of H. M. Torpedo-Boat Destroyer "Tartar." Illustrates the vessel and gives illustrated description of the six Thornycroft water-tube boilers. 700 w. Engng—Dec. 27, 1907. No. 89385 A.

Dredges.

An Electrically Operated Sea-Going Steam Dredge. Illustrated description of

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the sea-going dredge "Thor," designed for electrical operation of all winches and mechanisms. 1500 w. Int-Marine Engng—Feb., 1908. No. 89813 C.

Dry Docks.

Floating Docks. Harry R. Jarvis. Read before the N.-E. Coast Inst. of Engrs. & Shipbldrs. Classifies the various types, giving descriptions, especially of the details of self-docking types. 3500 w. Mech Engr—Jan. 18, 1908. No. 89863 A.

Heating.

The Heating and Ventilating of Ships. Sydney F. Walker. The present number discusses methods of heating available. Diagrams. 3500 w. Int Marine Engng—Feb., 1908. Serial, 1st part. No. 89814 C.

Lusitania.

The Cunard Liner Lusitania. Illustrated description of the construction of the vessel and its equipment, and report of performance. 15000 w. Jour Am Soc of Nav Engrs—Nov., 1907. No. 89600 H.

Marine Transport.

Presidential Address of Mr. John Ward. Deals especially with the evolution of marine transport. 13500 w. Trans Inst of Engrs & Shipbldrs in Scotland—Oct. 22, 1907. No. 89686 N.

The Ocean Carrier. J. Russell Smith. Shows how certain types of carriers have been developed while other types have been discarded, and discusses the conditions that have affected modern ocean commerce. 5400 w. R R Gaz—Jan. 10, 1908. Serial, 1st part. No. 89446.

Mechanical Draft.

Mechanical Draft in Marine Practice. Walter B. Snow. Briefly reviews early applications, the process of development, American naval practice, and related matters. 3000 w. Int Marine Engng—Feb., 1908. Serial, 1st part. No. 89815 C.

Refrigeration.

Heat Insulation on Shipboard (Isolierungen an Bord). H. Schoeneich. A discussion of cold-storage for provisions on shipboard. Ills. Serial, 1st part. 2500 w. Schiffbau—Dec. 25, 1907. No. 89765 D.

Resistance.

The Coefficient k in the Formula for the Resistance of Flat and Prismatic Moving Bodies (Der Beiwert k in der Formel für den Wasserwiderstand bewegter plattenförmiger und prismatischer Körper). H. Engels and Fr. Gebers. A record of tests to establish the value of the coefficient k in the formula $W = k\ \gamma\ F\ v^2/2g$. Ills. Serial, 1st part. 5500 w. Schiffbau—Dec. 25, 1907. No. 89764 D.

Review of 1907.

Shipbuilding and Engineering in 1907. A review showing a decrease in tonnage, diminution in profits, and dismissal of workers. 9000 w. Engng—Jan. 3, 1908. No. 89526 A.

Speed.

The Fastest Ships in the World. Brief review of the growth in speed since the beginning of the century. 1500 w. Int Marine Engng—Feb., 1908. No. 89812 C.

Steam Boilers.

The Water-Tube Boiler with Schulz Superheater (Wasserkessel mit Ueberhitzer nach Patent Schulz). D. Dietrich. An installation suited to turbine steamers is described. Ills. 3500 w. Schiffbau—Dec. 11, 1907. No. 89763 D.

Steam Engines.

Engine Efficiency and Effective Turning Moments and Their Experimental Determination. Carl A. Richter. Trans. from the German. Discusses methods of measurement and apparatus used. Ills. 12000 w. Jour Am Soc of Nav Engrs—Nov., 1907. No. 89598 H.

Inertia and Torsional Stresses and Pressures on Bearings, Together with an Investigation of the Lubrication Problem, of the Port Main Engine U. S. S. Tennessee. Lewis Hobart Kenney. Gives computations and investigations made to determine the causes of the heating of the crank-pin and main bearings. 4000 w. Jour Am Soc of Nav Engrs—Nov., 1907. No. 89601 H.

See also British Navy and Steamships, under MARINE AND NAVAL ENGINEERING.

Steamships.

The Twin-Screw Allan Liner "Corsican." Drawings and illustrations of the machinery of this large merchant steamer, with brief notes. 300 w. Engng—Jan. 10, 1908. No. 89655 A.

See also Lusitania, under MARINE AND NAVAL ENGINEERING.

Steam Turbines.

The Turbine Plant of the "Mauretania." Illustrated description of the essential features of these large steam turbines. 3000 w. Power—Jan. 7, 1908. No. 89396.

Description and Test of 27-Inch Curtis Turbine for 50-Foot U. S. Navy Cutter. Paul E. Dampman. Ills. 1200 w. Jour Am Soc of Nav Engrs—Nov., 1907. No. 89599 H.

See also British Navy, and Lusitania, under MARINE AND NAVAL ENGINEERING.

Torpedo Boats.

The Development of Torpedo Craft. Archibald S. Hurd. Discusses the efficiency of the torpedo boat as revealed during the late war in the Far East, and describes recent vessels, especially those of the British Navy. Ills. 5000 w. Cassier's Mag—Jan., 1908. No. 89452 B.

Ventilation.

See Heating, under MARINE AND NAVAL ENGINEERING.

MECHANICAL ENGINEERING

AUTOMOBILES.

Berliet-Mixte.

The Six-Cylinder Berliet Marche Mixte. Illustrates and describes this engine, which is primarily a six-cylinder petrol motor, with its cylinders cast in pairs and valve chambers on the left-hand side of the engine. 1500 w. Autocar—Jan. 18, 1908. No. 89857 A.

Cabs.

The Development of Motor Cab Traffic in 1907 in Paris, London and Berlin (Die Weiterentwickelung des Motordroschkenverkehrs im Jahre 1907 in Paris, London und Berlin). Herbert Bauer. A review of experiences and financial returns. Ills. 5500 w. Zeitschr d Mit Motorwagen-Ver—Dec. 31, 1907. No. 89758 D.

Certus.

The "Certus" Friction-Driven Cars. Illustrated detailed description of gearless vehicles having a gradually variable speed mechanism. 1500 w. Auto Jour—Jan. 18, 1908. Serial, 1st part. No. 89854 A.

Commercial Vehicles.

See Cabs, Farm Motors, and Omnibuses, under AUTOMOBILES.

Control.

The Positive Driving System for Automobiles. M. C. Krarup. Discusses the principal causes of automobile accidents and presents the advantages of the system named. 4000 w. Ir Age—Jan. 2, 1908. No. 89291.

Electric.

Progress in Electric Automobile Construction (Ueber Fortschritte im Bau von Elektromobilen). W. A. Th. Müller. The first part of the serial discusses arrangement of motor and batteries, driving by front or rear axle, etc. Ills. Serial, 1st part. 5000 w. Elektrotech Zeitschr—Dec. 12, 1907. No. 89785 D.

See also Omnibuses, under AUTOMOBILES.

Farm Motors.

A New Agricultural Oil Motor. An illustrated article showing the possibilities of the kerosene traction engine on the farm. 1500 w. Sci Am Sup—Jan. 11, 1908. No. 89450.

Flywheels.

The Gyroscopic Action of a Fly-wheel. Roger B. Whitman. Explains gyroscopic action and its application to the flywheel of automobile engines as a cause of accidents. 1800 w. Automobile—Jan. 16, 1908. No. 89578.

Germany.

Automobiles in Germany (Automobileverkehr in Deutschland). Dr. R. Bürner. Gives statistics of the use of automobiles by provinces, the uses to which they are put, power, etc. 4000 w. Zeitschr d Mit Motorwagen-Ver—Dec. 31, 1907. No. 89759 D.

Ignition.

A New Step in Magneto Development. Ernest Coler. Illustrated description of the new Miller magneto. 1600 w. Automobile—Jan. 2, 1908. No. 89312.

Morriss.

The Morriss Steam Car. Illustrated detailed description. 2000 w. Auto Jour—Dec. 28, 1907. No. 89372 A.

Motors.

An Interesting Chapter from the Past. Pol Ravigneaux. Trans. from *La Vie Automobile*. A short résumé of Daimler's career, describing his internal-combustion motors. 1700 w. Automobile—Jan. 16, 1908. No. 89579.

Omnibuses.

Petrol-Electric Motor Omnibuses. Describes the Hart-Durtnall polyphase alternating-current system. 2000 w. Elec Engr, Lond—Jan. 3, 1908. No. 89515 A.

The Hallford Petrol Electric 'Bus. Illustrated detailed description of a vehicle embodying the Stevens system and the "S. B. & S." drive. 2200 w. Auto Jour—Jan. 18, 1908. Serial, 1st part. No. 89855 A.

The Petrol-Electric Automobile (Le Automobile Petroleo-Elettriche). Describes the leading vehicles of this type, referring principally to omnibuses. Ills. 5000 w. Ing Ferroviaria—Dec. 16, 1907. No. 89704 D.

Reo.

The 18-H.P. Reo Car. Illustrated detailed description of a moderate priced car. 2200 w. Auto Jour—Jan. 4, 1908. Serial, 1st part. No. 89514 A.

Testing.

A Critical Examination of Some Methods of Measuring the Tractive Power of Automobiles (Examen Critique de quelques Méthodes de Mesure de la Puissance Utile des Voitures Automobiles). J. Auclair. Ills. 9500 w. Bul du Lab d'Essais—No. 12, 1907. No. 89714 F.

Weigel.

The 25 H.P. Weigel Car. Illustrated detailed description. 2300 w. Autocar—Jan. 11, 1908. No. 89640 A.

COMBUSTION MOTORS.

Crankshafts.

Crankshafts for Internal-Combustion Engines. George F. Fuller. Considers

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improvements in design and manufacture. Ills. 1200 w. Cassier's Mag—Jan., 1908. No. 89458 B.

Fuels.

The Use of Water and Steam in Internal-Combustion Engines. Henry Henderson. Shows the ideas and methods adopted by past and present inventors and manufacturers. 5000 w. Cassier's Mag—Jan., 1908. No. 89459 B.

Gas and Oil Engine Diagrams and Fuel Data. Peter Eyermann. Diagrams showing how various fuels act in internal combustion engines, with tables giving information on these fuels. 600 w. Power—Jan. 14, 1908. Serial, 1st part. No. 89541.

Gas-Engine Regulation.

Gas-Engine Regulation for Direct-Connected Units. Charles E. Lucke. Reviews some important papers on steam engine regulation, some of the phases being common to gas engines, giving a summary of the variations of conditions entering into the regulation problem and the conclusions of the study. 8500 w. Pro Am Inst of Elec Engrs—Feb., 1908. No. 89895 D.

Gas Engines.

The Gas Engine. Cecil P. Poole. Part first gives an illustrated explanation of the elementary principles, pressures and temperatures, cooling and heat loss, valves and valve-gear. 6500 w. Power—Jan. 14, 1908. Serial, 1st part. No. 89542.

The Explosion of Gases. John Batey. A discussion of the mechanical and thermodynamic effects of the explosions of gas in the cylinder of the gas engine. 2500 w. Cassier's Mag—Jan., 1908. No. 89453 B.

On the Measurement of Temperatures in the Cylinder of a Gas Engine. Prof. H. L. Callendar, and Prof. W. E. Dalby. An illustrated account of investigations and statement of conclusions. 6000 w. Engng—Dec. 27, 1907. No. 89387 A.

Largest Gas Engines for Electrical Work. Cecil P. Poole. Illustrates and describes construction details and operating data of the gas engines at the Martin station of San Mateo (Cal.) Power Co. 3000 w. Power—Jan. 14, 1908. Serial, 1st part. No. 89538.

300 Horse-Power Suction Gas Plant. Illustrates and describes a late design of twin-cylinder producer-gas engine. 1000 w. Engr, Lond—Dec. 27, 1907. No. 89393 A.

Four 4,000 H.P. Gas Engines. James Cooke Mills. Illustrated description of the installation for the California Gas and Electric Corporations, San Francisco. 700 w. Mach, N Y—Jan., 1908. No. 89345 C.

Gas-Engine Equipment of a Rolling Mill. Illustrated description of gas engines successfully operated on blast-furnace gas, in parallel with steam-driven units, in a large tube mill. 1000 w. Power—Jan. 21, 1908. No. 89665.

See also Fuels, under COMBUSTION MOTORS; Blast-Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL; and Electric Power, under MINING AND METALLURGY, MINING.

Gasoline Engines.

Gasoline Motors for Aeronautical Work. Illustrates and describes recent light weight motors of French design. 2800 w. Sci Am Sup—Jan. 11, 1908. No. 89451.

Gas Producers.

The Jahns System of Transforming Solid Fuel into Gas. Oskar Nagel. Illustrated description of the Jahns producer plant which is used in German and Belgian coal mines. 800 w. Elec-Chem & Met Ind—Jan., 1908. No. 89490 C.

Gas Producers (Les Gazogènes). An illustrated detailed description of the latest types of producers, charging devices, gas meters, and calorimeters. 7500 w. Rev de Mécan—Dec. 31, 1907. No. 89732 E + F.

Governing.

See Gas-Engine Regulation, under COMBUSTION MOTORS.

Oil Engines.

New Type of Internal Combustion Motor. H. Addison Johnston. Illustration, with brief description of an improved type of kerosene or crude oil engine of 60 h.p., fitted with a compressed air starting device. 1500 w. Sci Am Sup—Jan. 25, 1908. No. 89810.

See also Farm Motors, under AUTOMOBILES; and Fuels, under COMBUSTION MOTORS.

Troubles.

Cause and Effect in Engine Troubles. Herbert L. Towle. Considers the possible mechanical and electrical defects of internal-combustion engines and the effects which they produce. Ills. 3000 w. Rudder—Jan., 1908. Serial, 1st part. No. 89395 C.

HEATING AND COOLING.

Cooling Towers.

Cooling Towers. Charles L. Hubbard. Discusses some of the advantages, and describes the principle upon which a cooling tower operates, giving illustrated description of types. 2500 w. Elec Rev, N Y—Jan. 25, 1908. No. 89828.

Fan Blowers.

Variation in Fan Blower Efficiency. Walter B. Snow. Discusses the efficiency of operation in connection with heating and ventilating service. 2500 w. Met Work—Jan. 18, 1908. No. 89604.

Hot-Air Heating.

Furnace Heating of a Hotel. Plan and description of a building of eighty-three rooms served by two furnaces with trunk air mains. 1200 w. Met Work—Jan. 4, 1908. No. 89331.

Present Practice in Fan-Blast Heating. A report read before the Am. Soc. of Heat. & Vent. Engrs., giving questions and results of a canvass of hot-blast heating practice. 5800 w. Heat & Vent Mag—Jan., 1908. No. 89844.

Hot-Water Heating.

Data for the Design of Hot-Water Heating Systems. A revised report of the Committee on Hot-Water Heating, presented at the New York meeting of the Am. Soc. of Heat. & Vent. Engrs. 2000 w. Eng News—Jan. 30, 1908. No. 89927.

Industrial Buildings.

See Steam Heating, under HEATING AND COOLING.

Pipe Corrosion.

Relative Corrosion of Wrought Iron and Soft Steel Pipes. T. N. Thomson. Read before the Am. Soc. of Heat. & Vent. Engrs. An illustrated account of investigations with a summary of the conclusions. 3000 w. Heat & Vent Mag—Jan., 1908. No. 89843.

Refrigeration.

Modern Commercial Uses of Refrigeration. The present article deals with brewery refrigeration, illustrating machines used. 6000 w. Ice & Cold Storage—Jan., 1908. Serial, 1st part. No. 89535 A.

Pipe Line Refrigeration. R. H. Tait. Read at Jamestown Exposition Convention. Calls attention to the possibilities of extending the operation of refrigerating plants and so increasing the revenue. 1800 w. Ice & Cold Storage—Jan., 1908. No. 89536 A.

See also same title, under MARINE AND NAVAL ENGINEERING.

Steam Heating.

The Determination of Pipe Diameters in Steam Heating Plants (Bestimmung der Rohrdurchmesser bei Dampfheizungsanlagen). Max Hottinger. Illustrating by curves a mathematical discussion. Serial, 1st part. 1500 w. Gesundheits-Ing—Dec. 21, 1907. No. 89769 D.

Heating and Ventilating in the New Building of L. Löwe & Co., A.-G., Berlin (Heizung und Lüftung im Fabrikneubau der L. Löwe & Co. A.-G., Berlin). Theodor Fröhlich. Illustrates and describes the machinery and installations for heating and ventilating these extensive shops. 3000 w. Gesundheits-Ing—Dec. 28, 1907. No. 89770 D.

Ventilating.

Modern Systems for the Ventilation and Tempering of Buildings. Percival Robert Moses. A general review of the principles and available type of apparatus for furnishing an abundant supply of fresh tempered air. Ills. 5000 w. Engineering Magazine—Feb., 1908. No. 89879 B.

The Unhealthfulness of the Air of Living Rooms and its Improvement by Ozone (Ueber die Gesundheitsschädlichkeit der Luft bewohnter Räume und ihre Verbesserung durch Ozon). Dr. A. Lübbert. Discusses the vitiation of the air in dwellings and an ozone-generating apparatus for its regeneration. Ills. 4400 w. Gesundheits-Ing—Dec. 7, 1907. No. 89766 D.

See also Fan Blower, and Steam Heating, under HEATING AND COOLING; and Heating, under MARINE AND NAVAL ENGINEERING.

HYDRAULIC MACHINERY.

Air Lift.

Artesian Well Pumping by Compressed Air. H. Tipper. Explains the advantages of the air-lift system of delivering artesian water. 1700 w. Eng News—Jan. 16, 1908. No. 89571.

Air-Lift Pumps for Slimes. Illustrates and describes air lifts in use at the East Rand Proprietary Mines, Ltd., reporting tests. 3500 w. Engr, Lond—Jan. 10, 1908. No. 89657 A.

Centrifugal Pumps.

Investigation of Centrifugal Pumps. Clinton Brown Stewart. A discussion of the theory of the centrifugal pump and tests of a six-inch vertical centrifugal pump. Ills. 20000 w. Bul Univ of Wis, No. 173—Part 1. No. 89424 N.

Pumping.

Methods of Pumping Deep Ground Waters. Charles B. Burdick. Reviews the means now in use, their applicability and economy; referring particularly to supplies below suction depth. Discussion. Ills. 13000 w. Jour W Soc of Engrs—Dec., 1907. No. 89549 D.

Pumping Plants.

See Sewage Disposal, under CIVIL ENGINEERING, MUNICIPAL; and Irrigation and Reservoirs, under CIVIL ENGINEERING, WATER SUPPLY.

Pumps.

Hinged Cylinder Head for a Vertical Sinking Pump. A. H. Hale. Illustrated description. 600 w. Power—Jan. 28, 1908. No. 89886.

Turbine Plants.

Safety Devices for Pressure Conduits in Turbine Plants (Sicherheitsvorrichtungen für die Turbinenleitung). Discusses various devices for preventing excessive pressure, particularly the indirect-acting hydraulic safety valve. Ills. 2300

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w. Zeitschr f d Gesamte Turbinenwesen —Dec. 30, 1907. No. 89774 D.

Water Hoist.

The Loss of Power in Hoisting Water from Bore Holes (Die bei der Schöpfbewegung in Bohrlöchern entstehende Druckverminderung). Richard Sorge. A record of investigations to determine friction and other losses in this method of raising water. Ills. 3500 w. Glückauf—Dec. 14, 1907. No. 89737 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Manufacture and Tests of Double Ball Bearings. Illustrates and describes how Chapman bearings are produced by specialized tools, reporting comparative tests. 2500 w. Am Mach—Vol. 31, No. 4. No. 89804.

The Use of Ball Bearings on Electric Motors. States the principal advantages gained by their use, and considers also the disadvantages, illustrating types. 2500 w. Elec Rev, Lond—Jan. 10, 1908. No. 89646 A.

Ball and Roller Bearings in Practical Operation. Samuel S. Eveland. Discusses their design, giving tests and results obtained, illustrating and describing types and the methods of manufacture, etc. General discussion. 5800 w. Pro Engrs' Club of Phil—Oct., 1907. No. 89547 D.

Ball Bearings (Kugellager - Konstruktionen). Reviews the use of ball bearings on automobiles illustrating a large number of types of construction. 2700 w. Zeitschr d Mit Motorwagen-Ver—Dec. 15, 1907. No. 89757 D.

Chains.

The Strength of Chain Links (Beanspruchung der Kettenglieder). J. Stieghorst. A mathematical discussion. Ills. 2500 w. Schiffbau—Dec. 11, 1907. No. 89762 D.

Crane Hooks.

A Diagram for Designing Hoisting Hooks. Axel Pedersen. Gives diagram plotted from Prof. Bach's formula, explaining how hooks may be properly proportioned without using elaborate mathematics or tests. 1500 w. Am Mach—Vol. 31, No. 5. No. 89910.

Crankshafts.

See same title, under COMBUSTION MOTORS.

Dies.

A Press Die for Magnet-Head Punchings for Inclosed Arc Lamp. Julius F. A. Vogt. Illustrates and describes a method of laying out multiple follow dies. 1200 w. Am Mach—Vol. 31, No. 5. No. 89909.

Drying Drums.

Design of Rotating Drums. Discusses the principal points, considered in calculating the strength and proportion of rotating cylinders. Ills. 2500 w. Mach, N Y—Jan., 1908. No. 89344 C.

Gears.

The Safe Working Loads for Gear Teeth. Charles H. Logue. On the importance of proper design, giving formulæ. 3000 w. Am Mach—Vol. 31, No. 3. No. 89564.

The Variation of the Strength of Gear Teeth with the Velocity. Ralph E. Flanders. Some suggestions in regard to proposed tests of the influence of velocity on the safe stress. 2200 w. Mach, N Y—Jan., 1908. No. 89346 C.

The Design of Bevel Gears for Precision Machines (Berechnung von Kegelrädern für Präzisionsmaschinen). C. E. Berck. An illustrated mathematical paper giving formulæ. 1500 w. Zeitschr f Werkzeug—Dec. 25, 1907. No. 89756 D.

Roller Bearings.

Requisites of Practical Roller Bearings. J. F. Springer. How they should be classified; the constructive features which insure serviceability, etc. Ills. 1000 w. Power—Jan. 14, 1908. Serial. 1st part. No. 89539.

See also Ball Bearings, under MACHINE ELEMENTS AND DESIGN.

MACHINE WORKS AND FOUNDRIES.

Brass Castings.

A Troublesome Driving Brass Casting. Louis Luhrsen. An account of difficulties experienced in making a locomotive bearing. 1200 w. Foundry—Jan., 1908. No. 89409.

Bronze Foundry.

An Ornamental Bronze Foundry. Illustrated description of a new plant at Mt. Vernon, N. Y. 1800 w. Foundry—Jan., 1908. No. 89408.

Case-Hardening.

Quick Case - Hardening. Walter J. May. Brief description of process. 600 w. Prac Engr—Jan. 17, 1908. No. 89860 A.

Castings.

Steel Castings by the McHaffie Process. Illustrated description of the methods in use at Chester, Pa. 1000 w. Ir Trd Rev—Jan. 2, 1908. No. 89308.

Development of the Steel Casting Industry. W. M. Carr. Briefly considers the defects of early attempts, and the reasons for recent advances. 1500 w. Ir Trd Rev—Jan. 2, 1908. No. 89307.

The Szèkely Process of Casting in Metallic Moulds. Illustrated description. 400 w. Engng—Jan. 3, 1908. No. 89525 A.

See also Brass Casting, under MACHINE WORKS AND FOUNDRIES.

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Chain Making.

Chain-Stud Recessing Machine. Illustrated description of an interesting machine for chain work. 1100 w. Am Mach—Vol. 31, No. 1. No. 89283.

Cores.

Foundry Cores, Core Sand, and Core-Making Machinery. George H. Wadsworth. Abstract of an address before the Chicago Foundry Foremen. 2000 w. Am Mach—Vol. 31, No. 2. No. 89441.

Cupola Practice.

Melting Iron in the Foundry Cupola. Prof. H. McCormack. Describes work at the Armour Inst. of Technology undertaken to secure data, of economic value, on cupola practice. 1000 w. Elec-Chem & Met Ind—Jan., 1908. No. 89489 C.

Cylinder Grinding.

Machining Gasolene Engine Cylinders. Illustrates and describes the different operations of machining the cylinder and its valve chamber. 1800 w. Am Mach—Vol. 31, No. 4. No. 89800.

Extrusion Process.

Description of the Extrusion or "Squirting" Process for Making Brass Rods and Special Shapes. History with description of the machine and its operation. Ills. 2000 w. Brass Wld—Jan., 1908. No. 89682.

Forging.

See Crankshafts, under COMBUSTION MOTORS.

Foundries.

The Goulds Manufacturing Company's New Foundry. Illustrated description of a plant at Seneca Falls, N. Y., for the production of pump castings. 3500 w. Ir Age—Jan. 2, 1908. No. 89289.

See also Bronze Foundry, under MACHINE WORKS AND FOUNDRIES.

Foundry Design.

Design of the Iron Foundry. Oscar E. Perrigo. Discusses its location and the arrangement of various departments. 2200 w. Foundry—Jan., 1908. No. 89411.

Foundry Furnaces.

Electric Furnaces for the Iron and Brass Foundry. John B. C. Kershaw. Deals with the use of electricity for melting, showing that under certain conditions it may prove economic. Ills. 2500 w. Ir Trd Rev—Jan. 2, 1908. No. 89306.

Foundry Practice.

The Situation of Modern Foundry Practice (Stand des modernen Eisengiessereiwesens). O. Leyde. A review of progress. 3500 w. Stahl u Eisen—Dec. 4, 1907. No. 89730 D.

See also Cupola Practice, under MACHINE WORKS AND FOUNDRIES.

Furnaces.

Fuel Oil for General Shop-Furnace Use. Holden A. Evans. Illustrated description of the construction and operation of furnaces successfully and economically fired with oil at the Mare Island Navy Yard. 5500 w. Am Mach—Vol. 31, No. 5. No. 89907.

See also Foundry Furnaces and Tempering Ovens, under MACHINE WORKS AND FOUNDRIES.

Gear Cutting.

Gear-Cutting Machinery. Ralph E. Flanders. An illustrated article dealing with methods of cutting gear teeth, the machinery and its operation. 6500 w. Mach, N Y—Jan., 1908. Serial, 1st part. No. 89347 C.

A Hobbing Machine and Dividing-Head Tests. Illustrated description of how accurate worm wheels for dividing heads are hobbed in a special machine and the heads afterwards tested. 2000 w. Am Mach—Vol. 31, No. 1. No. 89282.

Gun Making.

Interesting Work at Watervliet. Illustrates and describes backing off hardened taps with a grinder, shaping octagon holes, rifling a gun slope, and other work. 2000 w. Am Mach—Vol. 31, No. 2. No. 89439.

Hardening.

Hardening Methods of a Large Shop. C. R. Clover. Describes methods of work. 1800 w. Am Mach—Vol. 31, No. 4. No. 89803.

Lapping.

Accurate Lapping Operations and Small Tools. Illustrated description of how the members of the mold used in the monotype casting machine are finished accurately by grinding and lapping. 2000 w. Am Mach—Vol. 31, No. 4. No. 89801.

Lathes.

The Gridley Multiple Spindle Automatic. Illustrates and describes a new turret lathe for simultaneous operations on four bars of stock. 2000 w. Ir Age—Jan. 30, 1908. No. 89906.

New Lathes (Neuerungen an Drehbänken). The first part of the serial is devoted to an illustrated description of new lathes recently brought out by the Gebrüder Böhringer, Göppingen. Serial, 1st part. 2000 w. Zeitschr f Werkzeug—Dec. 5, 1907. No. 89754 D.

Machine Tools.

Machine Tools for Gas Engine Construction. Illustrates and describes recent British machine tools in the present number. 2000 w. Cassier's Mag—Jan., 1908. Serial, 1st part. No. 89460 B.

Management.

System in Sheet Metal Work. Illustrated account of a system applied in a shop at Cleveland, O. 2200 w. Met Work—Jan. 11, 1908. No. 89469.

Theory and Practice of Shop and Factory Management. Oscar E. Perrigo.

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Fourth of a series of articles on cost keeping and shop management. 3000 w. Ir Trd Rev—Jan. 2, 1908. No. 89309.

See also Tool Rooms, under MACHINE WORKS AND FOUNDRIES; and Inventory, Purchasing, and Stores Keeping, under INDUSTRIAL ECONOMY.

Metallic Molds.

See Casting, under MACHINE WORKS AND FOUNDRIES.

Microscope.

The Microscope in the Manufacturing Plant. F. A. Stanley. Illustrates and describes some of the advantages of the microscope in connection with manufacturing processes. 1200 w. Am Mach—Vol. 31, No. 3. No. 89560.

Milling.

Machining a Turret-Lathe Turning Tool. A. J. Baker. Illustrates and describes some jigs and fixtures that are indexed to set the work at the proper angles while milling and drilling. 1500 w. Am Mach—Vol. 31, No. 1. No. 89284.

Milling Operations on Vise Parts. John Edgar. Illustrates and describes how the different phases of machining are done on the milling machine. 2000 w. Mach, N Y—Jan., 1908. No. 89349 C.

Milling Cutters.

Notes on the Manufacture and Upkeep of Milling Cutters. Dr. H. T. Ashton. Describes a system of manufacture developed particularly to meet the difficulties of high-speed steel. Ills. 3000 w. Inst of Mech Engrs—Dec. 20, 1907. No. 89382 N.

Molding.

Method of Molding Large Bed Plate. W. W. McCarter. Illustrated description of the method employed in making the bed plate for an anti-friction pulverizer. 1500 w. Foundry—Jan., 1908. No. 89410.

Molding Machines.

Molding with Machinery. Joseph H. Hart. Describes some applications of mechanical devices to molding. 1800 w. Am Mach—Vol. 31, No. 3. No. 89563.

Molds.

See Castings, under MACHINE WORKS AND FOUNDRIES.

Planer.

The Largest Planer in the World. Illustrated description of a machine weighing over 420 tons and requiring more than 200-h.p. to drive it. 3800 w. Am Mach—Vol. 31, No. 1. No. 89281.

Pneumatic Tools.

Pneumatic Power Hammer Tests. Illustrates and describes interesting tests made to show the amount of power consumed in driving three different sizes. 500 w. Engr, Lond—Jan. 17, 1908. No. 89875 A.

Rake Making.

Tools for Making Garden Rakes. Julius F. A. Vogt. Sketches and description. 1000 w. Am Mach—Vol. 31, No. 3. No. 89561.

Shops.

The Creation of a Manufacturing Plant. Walter B. Snow. Illustrated account of the building of the new works of the B. F. Sturtevant Co., Hyde Park, Mass. 2500 w. Columbia Engr—1906. No. 89496 N.

The Establishments of Henschel and Son at Cassel, Rothenditmold and Hattingen am Ruhr (Etablissements Henschel und Sohn, Cassel—Rothenditmold Hattingen am Ruhr). Robert Le Chatelier. A description of these locomotive and heavy machinery shops. Ills. 5500 w. Rev d Métall—Dec., 1907. No. 89716 E + F.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT; and under STREET AND ELECTRIC RAILWAYS.

Steam Hammers.

A New Steam Hammer (Ein neuer Dampfhammer). B. Simmersback. Illustrated description. 1600 w. Zeitschr f Werkzeug—Dec. 15, 1907. No. 89755 D.

Tempering Ovens.

Electric Heating and Tempering Ovens (Elektrische Glüh- und Harteöfen). Illustrates and describes types and compares the cost of operation with that of gas-fired ovens. 2000 w. Elektrochem Zeitschr—Dec., 1907. No. 89728 D.

Tool Making.

See Milling, under MACHINE WORKS AND FOUNDRIES.

Tool Rooms.

Tool-room Arrangement and System. William H. Taylor. Discusses the laying out, fitting with racks and boxes, and the general management. 2800 w. Am Mach—Vol. 31, No. 4. No. 89802.

Welding.

Electric Welding. C. B. Auel. Detailed description of the Benardos process as applied in connection with steel castings, pipes and plates. Ills. 2200 w. Elec Jour—Jan., 1908. No. 89679.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

See Columns, under CIVIL ENGINEERING, CONSTRUCTION.

Metallography.

The Microscopic Examination of Metals, Alloys, and Other Opaque Material. William Campbell. Explains the preparation of specimens and the methods used, and what the microscope tells. Ills. 4500 w. Columbia Engr—1906. No. 89497 N.

See also Wheels, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Specifications.

Specifications for Metallic Materials (Les Cahiers des Charges pour la Réception des Matières Métalliques). M. G. Charpy. A plea for more careful drawing and more rigid enforcement of specifications for materials of construction. 10800 w. Rev de Métall—Dec., 1907. No. 89715 E + F.

Steel.

Hand Bending Tests. Capt. H. Riall Sankey. Gives a comparison of some hand-bending tests. 900 w. Engng—Dec. 27, 1907. No. 89386 A.

Cold-Rolled and Cold-Drawn Steel Bars. Arthur J. Wood. Reports test results and conclusions. 2000 w. Eng News—Jan. 16, 1908. No. 89570.

The Variability of Steel. Alexander Jude. Abstract of paper read before the Staffordshire Iron & Steel Inst. Points out the great range of variation in test results, and considers the reasons for the variability. Ills. 600 w. Ir & Coal Trds Rev—Dec. 27, 1908. No. 89447 A.

MEASUREMENT.

Dynamometers.

A Magnetic Absorption Dynamometer. C. M. Garland. Illustrated description of a type where the power is transformed into heat in an armature revolving in a magnetic field, and the heat is absorbed by water. 1200 w. Am Mach—Vol. 31, No. 5. No. 89008.

Elastic Limit.

The Elastic Limit and the Testing of Materials. H. Gansslen. Considers the term "elastic limit" and methods of testing. 2000 w. Mach, N Y—Jan., 1908. No. 89348 C.

Gages.

Testing the Lead of Taps and Screws. Eric Oberg. Describes testing the lead by gages; and comparators for the lead of taps and screws. Ills. 1200 w. Mach, N Y—Jan., 1908. No. 89799 C.

Pyrometry.

The Chauvin and Arnoux Thermo-Electric Industrial Pyrometers (Sur les Pyromètres Thermo-Electriques Industriels de MM. Chauvin et Arnoux). M. J. Violle. An illustrated description of the principle and working of this instrument. 2500 w. Bul Soc d'Encour—Nov., 1907. No. 89717 G.

Testing Machines.

Hydraulic Diaphragm Testing-Machines. Briefly reviews the use of these hydraulic gauges, and especially considers the researches of Prof. A. Martens. Ills. 2500 w. Engng—Dec. 27, 1907. No. 89383 A.

Testing Materials.

Testing Materials by Impact on Nicked Bars (Die Kerbschlagprobe im Materialprüfungswesen). Dr. Ehrensberger. Records in curves and tables the results of extensive tests comparing this with other methods of testing and drawing conclusions as to its efficiency. Ills. Serial, 1st part. 3500 w. Stahl u Eisen—Dec. 11, 1907. No. 89734 D.

See also Elastic Limit, under MEASUREMENT; and Education, under INDUSTRIAL ECONOMY.

Thermometry.

See Gas Engines, under COMBUSTION MOTORS.

POWER AND TRANSMISSION.

Air Compressors.

See Turbo-Compressors, under POWER AND TRANSMISSION.

Compressed Air.

See Tidal Power, under POWER AND TRANSMISSION; Tunnels, under CIVIL ENGINEERING, CONSTRUCTION; and Compressed Air, under MINING AND METALLURGY, MINING.

Electric Driving.

The Electric Driving of Rolling Mills. William T. Dean. An illustrated study of the conditions to be met in the application of electricity, favoring the steam turbine as a generating unit. 4500 w. Ir Trd Rev—Jan. 2, 1908. No. 89305.

The Electrically-Driven 30-Inch Universal Plate Mill of the Illinois Steel Co. Illustrated description of the electric drive for this heavy reversing mill. 5000 w. Ir Trd Rev—Jan. 9, 1908. No. 89430.

See also Armor Plates, under MINING AND METALLURGY, IRON AND STEEL.

Electric Power.

Cost of Electrical Power for Industrial Purposes. John F. C. Snell. Compares the costs of supply from town installations and power companies, and their relation to the cost of production from plant of various kinds installed in factories, discussing the economical possibilities. 9500 w. Inst of Elec Engrs—1907. No. 89671 N.

Lubricants.

See Boiler Waters, under STEAM ENGINEERING.

Lubrication.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Mechanical Plants.

Mechanical Plant of the Stuyvesant High School New York. Describes a building to be devoted to instruction in manual training and the mechanical plant to serve it. Ills. 3500 w. Eng Rec—Jan. 18, 1908. Serial, 1st part. No. 89613.

Tidal Power.

Compressing Air by Tidal Power. William A. Webber. Illustrates and describes

details of the plant at Rockland, Me. 1200 w. Am Mach—Vol. 31, No. 2. No. 89440.

Turbo-Compressors.

A Review of the Theories of the Turbo-Compressor (Zusammenstellung der Theorien von Turbokompressoren). Rudolf Mewes. A comparison of the aerodynamic and thermodynamic principles of design. Ills. 3000 w. Die Turbine—Dec. 20, 1907. No. 89771 D.

STEAM ENGINEERING.

Boiler Design.

Estimating the Cost of a Return Tube Boiler. F. C. Douglas Wilkes. Shows how the cost is estimated. 4500 w. Boiler Maker—Jan., 1908. No. 89286.

Estimating the Horsepower of Boilers and Engines. A. S. Atkinson. A discussion of some things that affect the Boiler's capacity. 2000 w. Boiler Maker—Jan., 1908. No. 89287.

Boiler Furnaces.

A Boiler Furnace for Burning High-Volatile Coals. Describes a furnace with water-tube boilers, used in the Rocky Mt. region, for burning lignites and similar fuel, which embodies an application of the gas-producer method. 1700 w. Eng Rec—Jan. 11, 1908. No. 89467.

See also Smoke Prevention, under STEAM ENGINEERING.

Boiler Management.

Fuel Economy. L. J. Wing. Read before the Am. Soc. of Heat. & Vent Engrs. Brief suggestions on the subject of grates and draft. 1200 w. Heat & Vent Engrs—Jan., 1908. No. 89845.

See also Fuels, under STEAM ENGINEERING.

Boiler Plates.

The Formation of Cracks in Boiler Plates (Der heutige Stand der Frage der Rissbildung in Kesselblechen). R. Baumann. Discusses the effects of construction, materials and operation on the question of the cracking of boiler plates. 7700 w. Zeitschr d Ver Deutscher Ing—Dec. 14, 1907. No. 89780 D.

Boilers.

See Destroyer and Steam Boilers, under MARINE AND NAVAL ENGINEERING.

Boiler Waters.

Water for Economical Steam Generation. J. C. William Greth. Gives facts relating to savings in actual water-softening plants. 3500 w. Engineering Magazine—Feb., 1908. Serial, 1st part. No. 89882 B.

Simple Methods of Testing Feed-Water and Lubricants. James E. Noble. Brief description of methods and treatment. 1700 w. Power—Jan. 14, 1908. No. 89540.

The Purification of Feed-Water. Charles L. Hubbard. Considers methods of purifying the water before it is fed to the boilers. Ills. 2500 w. Elec Rev, N Y—Jan. 4, 1908. Serial, 1st part. No. 89337.

Some Notes on the Electrical Purification of Feed Water. Refers to the working of a purifying plant on the Davis-Perrett electrical system, capable of dealing with 8,000 gallons of water per hour. 1500 w. Elec Engr, Lond—Jan. 17, 1908. No. 89864 A.

Condensers.

See Engine Efficiency, under STEAM ENGINEERING.

Cooling Towers.

See same title, under HEATING AND COOLING.

Cylinder Condensation.

Cylinder Condensation and Preventives. Discusses steam jacketing, superheating, and compounding. 2000 w. Engr, U S A—Jan. 1, 1908. No. 89280 C.

Engine Bearings.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engine Design.

See Boiler Design and Thermodynamics, under STEAM ENGINEERING.

Engine Efficiency.

The Influence of Back Pressure on the Steam Consumption of Reciprocating Engines (Der Einfluss des Gegendruckes und der Zwischendampfentnahme auf den Dampfverbrauch von Kolbendampfmaschinen). Chr. Eberle. Gives in curves and tables the results of extensive tests. Ills. Serial, 1st part. 7000 w. Zeitschr d Ver Deutscher Ing—Dec. 21, 1907. No. 89781 D.

Steam Engine Economies. Thomas Hall. Discusses the economy of reducing the pressure for light loads. 1000 w. Sib Jour of Engng—Jan., 1908. No. 89887 C.

Engine Erection.

Lining Up a Horizontal Engine. T. E. O'Donnell. Simple and complete directions. Ills. 3300 w. Engr, U S A—Jan. 1, 1908. No. 89279 C.

Engine Foundations.

Foundations for the Steam Engine. Considers the materials used and the requirements for a good foundation. Ills. 3500 w. Engr, U S A—Jan. 1, 1908. No. 89278 C.

Engine Governing.

See Valve Setting, under STEAM ENGINEERING.

Engine Lubrication.

See Boiler Waters, under STEAM ENGINEERING; and Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engines.

Historical Sketch of the Steam Engine.

We supply copies of these articles. See page 1103.

An illustrated review of its development and its inventors. 2000 w. Engr, U S A —Jan. 1, 1908. No. 89277 C.

The Large Billet Mill Engine at the Donora Steel Works. Illustrated description of the horizontal girder frame engine to drive the 30-inch billet mill of the Carnegie Steel Co. 1400 w. Ir Trd Rev—Jan. 23, 1908. No. 89818.

A Novel High-Speed Engine. Description and illustrations of an engine designed by C. Lee Cook. The special features are the governor and a collapsible slide valve. 1800 w. Engr, U S A—Jan. 15, 1908. No. 89591 C.

See also Steam Engines and Steamships, under MARINE AND NAVAL ENGINEERING.

Entropy Diagram.

Use of the Entropy Diagram in Engine Tests. Sidney A. Reeve. Directions for constructing an entropy diagram from a steam engine indicator diagram. 2000 w. Power—Jan. 21, 1908. Serial, 1st part. No. 89668.

Exhaust Steam.

See Turbines, under STEAM ENGINEERING.

Flue-Gas Analysis.

A New CO_2 Recorder. C. O. Mailloux. Illustrated description of an improved apparatus for flue-gas analysis, with remarks on the utility of such records, etc. 5400 w. Pro Am Inst of Elec Engrs—Jan., 1908. No. 89324 D.

Fuels.

A Comparison of the Results of 400 Boiler Tests with Coals from Various Parts of the United States. Gives the general conclusions drawn from tests made by the U. S. Geol. Survey at St. Louis. 600 w. Eng News—Jan. 30, 1908. No. 89920.

See Comparison, under MINING AND METALLURGY, COAL AND COKE.

Heat Transmission.

A Study of the Movement of Heat in the Walls of Steam Engine Cylinders (Etude sur le Mouvement de la Chaleur dans les Parois des Cylindres de Machines à Vapeur). F. Thonet. A mathematical discussion. Ills. 7500 w. Rev de Mécan—Dec. 31, 1907. No. 89731 E + F.

Mean Pressure.

Mean Effective Pressure. Fred R. Low. Explains what it means, and how it is computed with and without clearance. 2500 w. Power—Jan. 21, 1908. No. 89666.

Mechanical Draft.

See same title, under MARINE AND NAVAL ENGINEERING.

Packings.

Labyrinth Packings. Describes a packing adopted by C. A. Parsons to diminish leakage losses in his steam turbine, and gives formula for calculating the discharge through the packing. 2000 w. Engng—Jan. 10, 1908. No. 89651 A.

Plants.

See Central Stations and Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Saturated Steam.

Methods of Determination of the Amount of Liquid Water Mechanically Mixed with the Steam of Boilers (Méthodes de Détermination de l'Eau Liquide Mécaniquement Entrainée par la Vapeur des Chaudières). Ills. 3500 w. Génie Civil—Dec. 21, 1907. No. 89727 D.

Smoke Prevention.

How to Burn Illinois Coal Without Smoke. L. P. Breckenridge. Discusses the principles that apply to smokeless furnace construction and operation, illustrating by units in actual operation. Ills. 12000 w. Univ of Ills—Bul. No. 15. No. 89429 N.

Specific Heats.

Specific Heats of Nitrogen, Carbon Dioxide, and Steam. Gives particulars of recent investigations conducted by Prof. L. Holborn and Prof. F. Henning in the Reichsanstalt. 2000 w. Engng—Jan. 3, 1908. No. 89521 A.

Superheating.

Fittings for Superheated Steam. Information from a paper by A. H. Kruesi, presented at the last meeting of the Assn. of Edison Ill. Cos. 1800 w. Elec Wld —Feb. 1, 1908. No. 89918.

See also Cylinder Condensation, under STEAM ENGINEERING; and Steam Boilers, under MARINE AND NAVAL ENGINEERING.

Thermodynamics.

The Practical Significance of the Carnot Cycle. Joseph H. Hart. A simple discussion of the fundamental principles of engine design. 3000 w. Cassier's Mag —Jan., 1908. No. 89455 B.

Turbines.

Mechanical Points in Connection with Steam Turbines. Discusses steam pipe, couplings, bearings, oil service, governing, etc. 4800 w. Engr, Lond—Dec. 27, 1907. No. 89388 A.

The Willans-Parsons Steam-Turbine. Plates and detailed description of these turbines and their construction. 6000 w. Engng—Jan. 3, 1908. No. 89522 A.

An Exhaust Steam Turbine Plant. Henry H. Wait. Illustrated detailed description of a low-pressure turbine equipment at the Wisconsin Steel Company's mill at South Chicago, with report of results. 6500 w. Pro Am Inst of Elec Engrs—Jan., 1908. No. 89323 D.

Low-Pressure Turbines for Exhaust

We supply copies of these articles. See page 1103.

Steam (Niederdruckturbinen für Auspuffdampf). W. Heym. Discusses their design and operation and describes several leading installations. 3000 w. Die Turbine—Dec. 20, 1907. No. 89772 D.

See also Packings, under STEAM ENGINEERING; Electric Driving, under POWER AND TRANSMISSION; Central Stations and Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Steam Turbines, under MARINE AND NAVAL ENGINEERING.

Valve Setting.

Setting the Valves of the Fitchburg Engine. Herbert E. Collins. An illustrated, simple explanation of the valve motion and governor, with clear instructions for setting and adjusting the valves. 2500 w. Power—Jan. 28, 1908. No. 89884.

TRANSPORTING AND CONVEYING.

Cableways.

Aerial Ropeway at Loch Leven. Illustrated description of the ropeway employed in the construction of the dam in this valley. 1200 w. Engr, Lond—Jan. 10, 1908. No. 89659 A.

Cableways (Kabelbahnen). J. André de la Porte and A. Snethlage. Discusses cableways for various types of service and illustrates and describes several of the more important European installations. 9000 w. De Ingenieur—Dec. 14, 1907. No. 89788 D.

The Cableway from Oettingen to Differdingen of the Deutsch-Luxemburg Mining and Smelting Company (Die Drahtseilbahn Oettingen-Differdingen der Deutsch - Luxemburgischen Bergwerks- und Hütten Akt.-Ges.). A. Pietrkowski. Illustrates and describes a cableway for ore transport nearly eight miles long. 2000 w. Glückauf—Dec. 14, 1907. No. 89738 D.

See also Cranes, under TRANSPORTING AND CONVEYING.

Coal Handling.

See Conveyors, under TRANSPORTING AND CONVEYING.

Conveyors.

The Coaling Machinery at Savona Harbor. F. Collischonn. Trans. from *Elek. Kraftbetriebe und Bahnen*. Illustrated description of a station in Italy equipped with the Hunt system of movable elevators and with a cable railway on the same system. 2000 w. Elect'n, Lond—Jan. 17, 1908. No. 89868 A.

See also Cranes, under TRANSPORTING AND CONVEYING.

Cranes.

Crane Design. Alton L. Smith. Briefly outlines the development of lifting devices. 2500 w. Jour Worcester Poly Inst—Jan. 1908. No. 89696 C.

Modern Systems of Hoisting and Conveying. Walter G. Stephan. An illustrated outline of the systems available and the special field of each. 5000 w. Ir Trd Rev—Jan. 2, 1908. No. 89304.

Electrical Power in Railway Goods Warehouses. H. Henderson. A discussion of its advantages. Ills. 3500 w. Inst of Elec Engrs—Jan. 13, 1908. No. 89858 N.

Erection Traveler for the Genesee River Viaduct. Illustrated description of an overhead traveler used for viaduct erection on the Erie System. 1500 w. Eng Rec—Jan. 18, 1908. No. 89609.

See also Crane Hooks, under MACHINE ELEMENTS AND DESIGN.

Elevators.

Boiler Power for Elevators. Charles L. Hubbard. Explains method of computing the power for hydraulic and electric elevators. 1500 w. Power—Jan. 28, 1908. No. 89885.

Ore Handling.

See Cableways, under TRANSPORTING AND CONVEYING; and Docks, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

MISCELLANY.

Aeronautics.

A Review of Progress in Aerial Navigation. Editorial review of the more important efforts to solve the problems of aërial navigation. 2500 w. Eng News—Jan. 16, 1908. No. 89572.

The Roe Aeroplane. Photographs and descriptions of a full-sized man-carrying machine. 1000 w. Auto Jour—Dec. 28, 1907. No. 89373 A.

New European Aeroplanes and Airships. Illustrates and describes the latest models, and motors. 1500 w. Sci Am—Jan. 18, 1908. No. 89575.

Henry Farman's Record Flight. An illustrated account of the flight that won the Deutsch-Archdeacon prize. 2000 w. Auto Jour—Jan. 18, 1908. No. 89856 A.

Farman Wins $10,000 Prize for Kilometer Flight. Brief illustrated account of the test of the heavier-than-air machine and its success. 1000 w. Automobile—Jan. 16, 1908. No. 89577.

The Farman Aeroplane. A résumé of the flights made with the machine that won the Deutsch-Archdeacon prize. 2000 w. Sci Am Sup—Feb. 1, 1908. No. 89932.

See also Gasoline Engines, under COMBUSTION MOTORS.

Shipping Weights.

Graphic Estimation of Shipping Weights. C. F. Cukor. Gives a method of determining approximate shipping weights of hoisting engines which can be applied to any power-generating outfit. 600 w. Power—Jan. 21, 1908. No. 89669.

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MINING AND METALLURGY

COAL AND COKE.

Accidents.

Fatal Accidents in Coal Mines. Frederick L. Hoffman. Reports the number of men killed in coal mines of North America in 1906, discussing causes. 2800 w. Eng & Min Jour—Jan. 4, 1908. No. 89403.

The Waste of Life in American Coal Mining. Clarence Hall and Walter O. Snelling. Discusses the loss of life in the mines of the United States as compared with Europe, the causes and remedy. 6500 w. Engineering Magazine—Feb., 1908. No. 89877 B.

See also Explosions, under COAL AND COKE.

Briquetting.

Briquetting of Fuels in British Columbia. Description of Pacific Coal Company's Plant at Bankhead, Alberta. G. J. Mashek. Ills. 1200 w. Can Min Jour—Jan. 15, 1908. Serial. 1st part. No. 89631.

Cape Breton.

Coal Mining in Cape Breton During 1907. A review of the year, predicting a steady increase in production. 2500 w. Can Min Jour—Jan. 15, 1908. No. 89630.

Coke-Oven Gas.

See Blast-Furnace Gas, under IRON AND STEEL.

Coke Ovens.

Retort versus Beehive Coke-Ovens. Alfred Ernst. A comparison of costs and economies in operation. 2000 w. Ir Age—Jan. 16, 1908. No. 89559.

The Sheldon Retort Coke Oven and Process. S. B. Sheldon. Illustrates and describes this system, the special features being a chamber for precoking and the coal under compression during the coking operation. 4500 w. Ir Age—Jan. 16, 1908. No. 89557.

The Armstrong By-Product Coke Oven. Illustrates and describes this verticircular oven for manufacturing high-class coke and saving all the by-products. 1600 w. Col Guard—Jan. 17, 1908. No. 89869 A.

Coking Plants.

A Recent Plant for the Utilization of Small Coal. E. M. Hann. From Pro. S. Wales Inst. of Engrs. Illustrates and describes the by-product coke oven and coal washing plant at Bargold, Wales, and its operation. 4500 w. Ir & Coal Trds Rev—Jan. 17, 1908. No. 89876 A.

Comparison.

Pure Coal as a Basis for the Comparison of Bituminous Coals. W. F. Wheeler. A discussion based upon work in the laboratories of the State University of Illinois. 3500 w. Bul Am Inst of Min Engrs—Jan., 1908. No. 89890 C.

Electric Power.

See same title, under MINING.

England.

Coal Mining in Northumberland, England. George Raylton Dixon. Describes in detail the methods adopted in working out the coal so as to take advantage of the seams' cleavage. Ills. 3000 w. Eng & Min Jour—Jan. 25, 1908. No. 89839.

Explosions.

Monongah Mine Disaster. H. H. Stoek. Illustrated description of the methods of working these mines in W. Va., and the conditions before and after the explosion. 2500 w. Mines & Min—Jan., 1908. No. 89335 C.

Coal Dust as a Cause of Mine Explosions. Day Allen Willey. A discussion of recent disasters which seem to indicate that coal dust was the cause. 1800 w. Sci Am—Feb. 1, 1908. No. 89929.

See also Accidents and Explosives, under COAL AND COKE.

Explosives.

Miss-Fires and the Ignition of Firedamp with Permitted Explosives. From *Annales des Mines.* Report of investigations in France. 2000 w. Col Guard—Dec 27, 1907. No. 89381 A.

Safety Explosives (Sicherheitssprengstoffe). Karl Scholze. Results of tests on various explosives relating to force, products, temperature of detonation, etc. Ills. Serial. 1st part. 2500 w. Oest Zeitsch f Berg- u Hüttenwesen—Dec. 21, 1907. No. 89743 D.

Kentucky.

The Middleboro Coal Fields, Kentucky. John Howard. An illustrated account of a district mined entirely by drifts and slopes. 2400 w. Eng & Min Jour—Jan. 18, 1908. No. 89623.

Leasing System.

Leasing the Federal Coal Lands. H. Foster Bain. Present arguments for and against the proposed leasing system for United States coal lands. 2000 w. Min & Sci Pr—Jan. 11, 1908. No. 89584.

Mine-Gas Detection.

An Apparatus for Indicating Fire Damp in Coal Mines. Illustrates and describes the invention of Henry Guy Carleton. 1600 w. Sci Am—Jan. 11, 1908. No. 89448.

Mining.

See Economics, under MINING.

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Production.

The Coal Production of the World, 1864-1907. A review of the production in the principal coal-producing countries. 2200 w. Min Wld—Jan. 25, 1908. No. 89848.

Railway Properties.

See Coal Lands, under RAILWAY ENGINEERING, MISCELLANY.

Rescue Appliances.

Breathing Apparatus in Mines. Considers the requirements and describes the principal types that have been experimented with in Europe. Ills. 5000 w. Mines & Min—Jan., 1908. No. 89332 C.

Reviews of 1907.

The Coal and Coke Trades of the United Kingdom in 1907. General, and district reviews. 12000 w. Ir & Coal Trds Rev—Jan. 3, 1908. No. 89531 A.

Coal Mining in the United States in 1907. Reviews, by different authors, of the general mining conditions of important anthracite and bituminous centers. 15000 w. Eng & Min Jour—Jan. 4, 1908. No. 89406.

Shaft Stations.

Pit Bottom Arches and General Arrangements for Modern Collieries. J. S. Barnes. Considers details of arrangement and design and the method of procedure in determining the various factors. 4500 w. Ir & Coal Trds Rev—Jan. 10, 1908. Serial. 1st part. No. 89662 A.

Tipples.

See same title, under MINING.

Wages.

See same title, under MINING AND METALLURGY, MINING.

Washing.

See Coking Plants, under COAL AND COKE.

Wyoming.

The Diamondville Coalfield, Wyoming. A. T. Shurick. Describes the systems of mining. Ills. 2200 w. Eng & Min Jour—Jan. 11, 1908. No. 89478.

The Coal Mines of Southern Wyoming. Floyd W. Parsons. Information concerning the deposits and their development Ills. 1400 w. Eng & Min Jour—Jan. 11, 1908. No. 89479.

COPPER.

Alaska.

The Copper River District, Alaska. W. M. Brewer. Brief discussion of the projected lines of railway is given in the present number. 2500 w. Min & Sci Pr—Jan. 11, 1908. Serial. 1st part. No. 89583.

Assaying.

Electrochemical Analysis with Rotating Anodes in the Industrial Laboratory. Andrew M. Fairlie and Albert J. Bone. Illustrated description of a system of rotating anodes evolved in the laboratory of the Tennessee Copper Co. for the estimation of copper in slags and other products. 1000 w. Elec-Chem & Met Ind—Jan., 1908. Serial. 1st part. No. 89488 C.

Australia.

The Production of Copper in South Australia. John Plummer. Describes the mines, their development and production. 1200 w. Min Wld—Jan. 4, 1908. No. 89367.

British Columbia.

Notes on the Tyee Copper Mine. Walter Harvey Weed. Describes the peculiar characteristics of the ore bodies in the coast region of Vancouver Island, B. C. 2000 w. Eng & Min Jour—Jan. 25, 1908. No. 89834.

Colorado.

The Evergreen Copper-Deposit, Colorado. Etienne A. Ritter. Illustrates and describes a very peculiar and interesting deposit, in which both bornite and chalcopyrite occur as rock-minerals. 2500 w. Bul Am Inst of Min Engrs—Jan., 1908. No. 89889 C.

Congo Free State.

The Copper Mines of Katanza. Substance of a recent report by Robert Williams, giving information of the ores and their treatment. 1800 w. Eng & Min Jour—Jan. 25, 1908. No. 89835.

Converter Hoods.

Movable Converter Hoods. A. H. Wethey. Detail drawings with description of hoods in use at the Butte Reduction Works. 700 w. Eng & Min Jour—Jan. 11, 1908. No. 89474.

Flue Dust.

The Deposition of Flue Dust. Charles F. Shelby. Gives results of a study made at Cananea, of flue dust deposition and its sizes at different distances from the furnaces. 800 w. Eng & Min Jour—Jan. 25, 1908. No. 89836.

Germany.

See Electric Power, under MINING.

Hungary.

See same title, under GOLD AND SILVER.

Mexico.

See same title, under GOLD AND SILVER.

Montana.

Methods of Mining and Handling Ore in Butte. Edwin Higgins. Data concerning mines where the bulk of the ore comes from below the 1000-ft. level, and where electric power is extensively used. 1200 w. Eng & Min Jour—Jan. 11, 1908. No. 89473.

Nevada.

The Nevada Copper Fields. A. Selwyn-Brown. Gives a brief survey of the principal copper centers of the State and describes several of the more important cop-

per-reduction plants. Ills. 4000 w. Engineering Magazine—Feb., 1908. No. 89880 B.

See also same title, under GOLD AND SILVER.

Peru.

The Cerro de Pasco Mining District, Peru. Clarence C. Sample. Map and illustrated description of the region with an account of an ancient silver camp, now the scene of extensive copper mining and smelting. 3000 w. Eng & Min Jour—Jan. 18, 1908. No. 89620.

Mining and Smelting at Cerro de Pasco, Peru. Clarence C. Sample. An illustrated account of methods old and new, used at these mines. 4000 w. Eng & Min Jour—Jan. 25, 1908. No. 89838.

Precipitation.

Precipitation of Copper from Cupriferous Waters. Frank H. Probert. Illustrated description of practice in handling cupriferous waters, with remarks and suggestions. 2200 w. Min & Sci Pr—Jan. 4, 1908. No. 89435.

Production.

The Copper Production of North America. Report of the production for 1907 in United States, Mexico, and Canada. 7000 w. Eng & Min Jour—Jan. 4, 1908. No. 89399.

The Copper Mining Industry, 1845-1907. Interesting information relating to the production in the United States and throughout the world. 2800 w. Min Wld—Jan. 25, 1908. No. 89847.

Pyritic Smelting.

See Gold Milling, under ORE DRESSING AND CONCENTRATION.

Smelter Contracts.

Relation Between the Assay-Value of Mill Products and Smelter Contracts. Gelasio Caetani. Shows how any contract may be expressed mathematically by a formula, and be analyzed. 1700 w. Min & Sci Pr—Jan. 4, 1908. No. 89434.

Smelters.

The Smelter of the Mammoth Copper Mining Company, at Kennett, California. Donald F. Campbell. Illustrates and describes this plant which has been recently much enlarged. 1800 w. Min & Sci Pr—Jan. 4, 1908. No. 89436.

Engineering Features of the Southwest Smelting and Refining Works, Jarilla Junction, N. Mex. Illustrated detailed description of features of design and construction for new copper smelting works. 4000 w. Eng Rec—Jan. 4, 1908. No. 89354.

See also Converter Hoods, under COPPER; and Electric Power, under MINING.

Smelting.

Copper Smelting in Tennessee. J. Parke Channing. Information concerning the working and progress during the past year. 10000 w. Min & Sci Pr—Jan. 18, 1908. No. 89816.

The Production of Converter-Matte from Copper-Concentrates by Pot-Roasting and Smelting. George A. Packard. Describes experiments made at the Missouri School of Mines. 1500 w. Bul Am Inst of Min Engrs—Jan., 1908. No. 89892 C.

The Metallurgy of Copper in 1907. Walter Renton Ingalls. Briefly considers the practice at different works, and the improvements introduced. 1300 w. Eng & Min Jour—Jan. 4, 1908. No. 89428.

See also Flue Dust and Peru, under COPPER; and Sulphur, under MINOR MINERALS.

Trade.

The Year in Copper. H. M. Cole. A review of the price movements for the year and the tremendous shrinkages. 2500 w. Ir Age—Jan. 2, 1908. No. 89294.

Utah.

See Mills, under ORE DRESSING AND CONCENTRATION.

GOLD AND SILVER.

Assaying.

Notes on Cobalt Ores. W. K. McNeil. On the methods and apparatus employed in the assay of these complex ores. 900 w. Can Min Jour—Jan. 1, 1908. No. 89370.

The Assay of Telluride Ores. George T. Halloway and Leonard E. B. Pearse. An investigation of the causes of losses in treating telluride ores on a large scale and in assaying them, and how to avoid them. 9500 w. Inst of Min & Met, Bul. 39—Dec. 12, 1907. No. 89672 N.

See also Laboratory, under MINING.

Australia.

Mining Practice at Kalgoorlie, West Australia. Gerard W. Williams. An illustrated account of the gold mining. The telluride ores occur in lenses and are extracted by methods insuring good ventilation. 2000 w. Eng & Min Jour—Jan. 25, 1908. No. 89833.

Cobalt.

See Assaying, under GOLD AND SILVER.

Colorado.

See Placers, under GOLD AND SILVER.

Cyaniding.

Use of Compressed Air in Cyanidation. A. Grothe. Describes the method employed in New Zealand, known as the Brown process. 1500 w. Min Wld—Jan. 11, 1908. No. 89493.

See also Nevada, under GOLD AND SILVER.

Dredging.

Gold Dredging in 1907. John Power Hutchins. Discusses the attempts made

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to dredge frozen ground, variation in practice, steam-shovel dredging, etc. 2200 w. Eng & Min Jour—Jan. 4, 1908. No. 89425.

Gold Refining.

The Clean-Up, Melting and Refining of Gold Bullion. Gerard W. Williams. Describes methods used in South Africa. 2500 w. Min Wld—Jan. 4, 1908. No. 89368.

Homestake.

See Mine Fire, under MINING.

Hungary.

Nagybanya, Hungary. Edward Skewes. A descriptive account of this district of eastern Hungary, its mines of gold, silver, copper, etc., the methods of mining and milling, the management of the Government mines, and other subjects of interest. Ills. 5000 w. Min & Sci Pr—Jan. 11, 1908. No. 89582.

Hydraulic Mining.

Hydraulic Mining in British Columbia. Howard W. Dubois. Considers the conditions necessary for successful hydraulic operations, and shows what has been accomplished. 2500 w. Columbia Engr—1906. No. 89499 N.

See also Yukon, under GOLD AND SILVER.

Larder Lake.

The Larder Lake District. R. W. Brock. A report of this region, based on field work. Ills. 3000 w. Can Min Jour—Jan. 1, 1908. Serial. 1st part. No. 89371.

Mexico.

Mexico. Progress in 1907. C. A. Bohn. A review of the year. Map & Ills. 3500 w. Min & Sci Pr—Jan. 4, 1908. No. 89438.

The Mineral Resources of Sonora. F. J. H. Merrill. The chief metals are copper, gold and silver, though other metals are mined. The mines are discussed by districts. Map. 7000 w. Min & Sci Pr—Jan. 4, 1908. No. 89437.

The Promontorio Silver-Mine, Durango, Mexico. Francis Church Lincoln. Illustrated description of the vein, the ore, the relations of the primary vein-minerals, the mining, milling, etc. 4000 w. Bul Am Inst of Min Engrs—Jan., 1908. No. 89893 C.

Milling.

See Gold Milling, under ORE DRESSING AND CONCENTRATION.

Nevada.

Some Bullfrog Mines. W. H. Spaulding. Information concerning the Bullfrog reduction mill, the cyanide treatment, the Mayflower, Tramps, and Gold Bar mines. 2400 w. Eng & Min Jour—Jan. 18, 1908. No. 89621.

Nevada, the Silver State, and Government Irrigation in Nevada. The Truckee-Carson Project. Prof. Oscar C. S. Carter. Reviews the history of Nevada, its ore deposits, topography, climate, and the irrigation projects. Ills. & Map. 7000 w. Jour Fr Inst—Jan., 1908. No. 89553 D.

Genesis of the Formation and Deposition of the Nevada Desert Gold, Silver, and Copper Mines. Dr. Willis E. Everette. Thinks there was an upward radial deposition and percolation from the upthrust of a series of "laccoliths" which exist far below the surface. 7000 w. Sci Am Sup—Jan. 25, 1908. No. 89811.

New Mexico.

Genesis of the Lake Valley Silver-Deposits. Charles R. Keyes. Describes in detail the geology of this region in New Mexico, the ores and their mineralogic character, discussing their origin. 10000 w. Bul Am Inst of Min Engrs—Jan., 1908. No. 89888 C.

New Zealand.

The Waihi Gold Mine in New Zealand. Ralph Stokes. First of a series of illustrated articles describing the mines and methods. 2500 w. Min Wld—Jan. 11, 1908. Serial. 1st part. No. 89494.

Peru.

See same title, under COPPER.

Placers.

The Breckenridge Gold Placers, Colorado. Arthur Lakes. Illustrates and describes this region. 1100 w. Min Wld—Jan. 4,, 1908. No. 89366.

Production.

The World's Supply of Gold and Silver. Charles C. Schnatterbeck. Interesting statistics showing the progress made in the production. 6000 w. Min Wld—Jan. 25, 1908. No. 89846.

Gold, Silver, and Platinum in 1907. Frederick Hobart. Review of the influences and commercial conditions affecting the production of the precious metals. 3500 w. Eng & Min Jour—Jan. 4, 1908. No. 89398.

The Great Gold Mines. T. A. Rickard. A review of the production and profit of the world's greatest gold mines. 3000 w. Min & Sci Pr—Jan. 4, 1908. Serial. 1st part. No. 89432.

Rand.

The Origin of the Gold in the Rand Banket. Discussion of J. W. Gregory's paper on this subject. 13800 w. Inst. of Min & Met, Bul. 38—Nov. 14, 1907. No. 89675 N.

The Economics of the Deep-Deep Level Mines of the Rand. B. J. Collings. Discusses the serious financial side of such developments and other difficulties in working. 1000 w. Min Jour—Jan. 11, 1908. No. 89649 A.

See also Transvaal, under GOLD AND SILVER.

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Transvaal.

The Transvaal Mines—1907 Results. Gives comparison with 1906, and reviews the results of the year. 2500 w. Min Jour—Jan. 11, 1908. No. 89650 A.

Utah.

Mines of Tintic District, Utah. Robert B. Brinsmade. An illustrated description of the region and methods employed. 6000 w. Mines & Min—Jan., 1908. No. 89336 C.

Yukon.

Development of the Bonanza Creek Gold Mines. Francis C. Nicholas. An illustrated description of the region, with review of the past history, and account of present conditions. 1800 w. Min Wld—Jan. 8, 1908. No. 89632.

IRON AND STEEL.

Armor Plate.

The Use of Electricity in the Manufacture of Armor Plates. J. W. Warr. Describes the process of manufacture and comments on the applications made of electricity for power. Ills. 3500 w. Elec Rev, Lond—Dec. 27, 1907. No. 89374 A.

The Development of Armor-Plate Manufacture (Die Entwicklung der Panzer-Fabrikation). Max Kraleipper. A review of improvements in materials and processes of manufacture. 4000 w. Oest Zeitschr f Berg u Hüttenwesen—Dec. 21, 1908. No. 89742 D.

Blast-Furnace Gas.

The Use of Blast Furnace and Coke Oven Gas. F. E. Junge. Gives results of an investigation of the latest developments along this line in Germany. 5700 w. Ir Trd Rev—Jan. 2, 1908. No. 89302.

See also Gas Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Blast Furnaces.

The New Blast Furnace of the Shenango Furnace Co. at Sharpsville, Pa. Illustrated detailed description. 1500 w. Ir Trd Rev—Jan. 2, 1908. No. 89301.

The Inland Steel Company's New Furnace. Illustrated description of the new plant at Indiana Harbor, Ind. 2000 w. Ir Age—Jan. 16, 1908. No. 89558.

Recent Progress and Present Problems in the Blast-Furnace Industry. John J. Porter. A lecture before the Cincinnati Sec. of the Am. Chem. Soc. Discusses engineering and metallurgical problems connected with the operation of the blast furnace. 8800 w. Ir Trd Rev—Jan. 2, 1908. No. 89303.

Chute Process.

The Chute Steel-Making Process. Illustrated description of a process claiming to accomplish the same results attained by the duplex process, but in a simpler and much cheaper manner. 2000 w. Ir Trd Review—Jan. 23, 1908. No. 89819.

Electro-Metallurgy.

The Manufacture of High-Grade Steel in the Electric Furnace. Reviews articles by O. Thallner, in *Stahl und Eisen*, dealing with steel refining in general, and the Heroult furnace in particular. 2000 w. Elec-Chem & Met Ind—Jan., 1908. No. 89491 C.

A Modification of the Induction Furnace for Steel Refining. H. Wedding. Trans. from *Stahl und Eisen*. Illustrated description of a new development in the design of the induction furnace for steel refining at the Roechling works. 1400 w. Elec-Chem & Met Ind—Jan., 1908. No. 89486 C.

See also Foundry Furnaces, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Lake Superior.

Greatest Year in the Ore Ranges' History. Oliver J. Abell. Review of the record at the mines and on railroads and lakes. 5500 w. Ir Trd Rev—Jan. 2, 1908. No. 89310.

Lake Superior Iron Mining in 1907. Dwight E. Woodbridge. A review of the production, improved methods, developments, etc. 3500 w. Ir Age—Jan. 9, 1908. No. 89413.

Towns Built on Iron Ore Foundation. George E. Edwards. Describes the ore deposits and changes in methods of mining which will make necessary the removal of the village of McKinley and other towns in the Mesabi iron range. 2000 w. Min Wld—Jan. 11, 1908. No. 89495.

Operating Changes in the Lake Superior Iron Mines. Dwight E. Woodbridge. An account of recent and prospective changes in methods of operating the mines and handling the ores. 1000 w. Eng & Min Jour—Jan. 25, 1908. No. 89837.

Production.

Iron Ores Outside the Lake Superior Region. John Birkinbine. Gives a résumé of the sources from which iron ore is now derived in quantity, with suggestions. 2500 w. Ir Trd Rev—Jan. 2, 1908. No. 89311.

Rhode Island.

Contributions to the Geology of Rhode Island: I. Notes on the History and Geology of Iron Mine Hill, Cumberland. B. L. Johnson. II. The Petrography and Mineralogy of Iron Mine Hill, Cumberland. C. H. Warren. 11500 w. Am Jour of Sci—Jan., 1908. No. 89321 D.

Rolling Mills.

See also Gas Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS; Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION; and Engines, un-

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der MECHANICAL ENGINEERING, STEAM ENGINEERING.

Steel Making.

See Chute Process, under IRON AND STEEL.

Steel Works.

The Grey Structural Mill at South Bethlehem. Illustrated description of the Grey mill, which forms a part of the new Saucon plant. 2500 w. Ir Age—Jan. 2, 1908. No. 89288.

The Krupp Plant at Rheinhausen, Prussia (L'Asine Métallurgique de la Maison Krupp à Rheinhausen, Prusse). Abstracted from *Stahl u Eisen*. Plate. Ills. 3000 w. Génie Civil—Dec. 14, 1907. No. 89726 D.

See also Blast Furnaces, under IRON AND STEEL.

Tin Plate.

Making Tin Plate at Griffiths Iron Mills. Illustrated description of the process used in these charcoal iron mills. 1500 w. Met Work—Jan. 4, 1908. No. 89330.

The Sheet and Tin Plate Trades in 1907. B. E. V. Luty. A general review of the industry. 3800 w. Ir Age—Jan. 2, 1908. No. 89297.

Trade.

The Chicago Iron Trade in 1907. T. J. Wright. A review of the year, giving a summary of mill and furnace construction, and discussing the outlook. 3500 w. Ir Age—Jan. 2, 1908. No. 89295.

The Cincinnati Pig Iron Trade in 1907. James A. Green. A review of the year. 2800 w. Ir Age—Jan. 2, 1908. No. 89292.

The Philadelphia Iron Trade in 1907. A. A. Miller. A review of the year, the prices, material, etc. 4800 w. Ir Age—Jan. 2, 1908. No. 89296.

The Pittsburgh Iron Trade in 1907. Robert A. Walker. A general review. 5000 w. Ir Age—Jan. 2, 1908. No. 89293.

Ten Months' Prosperity in the Pittsburg District. W. B. Robinson. The story of the past year. 3500 w. Ir Trd Rev—Jan. 2, 1908. No. 89300.

The Iron and Steel Trades in 1907. General and district reviews of the trade in the United Kingdom. 1300 w. Ir & Coal Trds Rev—Jan. 3, 1908. No. 89532 A.

The Iron and Steel Industry in 1907. Reviews by various authors showing immense production, followed by partial collapse. 11000 w. Eng & Min Jour—Jan. 4, 1908. No. 89402.

The Iron Trade of the World with Special Reference to the Conditions of the United States. J. Stephen Jeans. A discussion of present conditions and the further outlook. 5500 w. Mfrs' Rec—Jan. 2, 1908. No. 89299.

The Future of the Iron and Steel Industry from a British Point of View. T. Good. 2500 w. Cassier's Mag—Jan., 1908. No. 89457 B.

LEAD AND ZINC.

Lead Refining.

The Direct Extraction and Refining of Lead by Electrolysis (Extraction Directe et Affinage du Plomb par Electrolyse). Jean Escard. A general review of various processes. Ills. 3000 w. Electricien—Dec. 21, 1907. No. 89722 D.

Lead Smelting.

The Metallurgy of Lead in 1907. Walter Renton Ingalls. Discusses the results of the processes in use. 2700 w. Eng & Min Jour—Jan. 4, 1908. No. 89427.

Leadville Geology.

Present Views of Genesis of Leadville Limestone Ores. S. F. Emmons. From Bull. 320, U. S. Geol. Surv. 2500 w. Eng & Min Jour—Jan. 11, 1908. No. 89476.

Milling.

See Zinc Milling, under ORE DRESSING AND CONCENTRATION.

Production.

The Production of Lead and Spelter in 1907. Review of mining conditions, giving statistics of production and price. 8000 w. Eng & Min Jour—Jan. 4, 1908. No. 89400.

The Production of Zinc Ores (Das Vorkommen der Zinkerze). Franz Petefs. Gives a review of zinc ore production in all the leading countries for the last three years. 3500 w. Glückauf—Dec. 21, 1907. No. 89739 D.

Zinc Smelting.

Zinc Smelting in the United States in 1907. Walter Renton Ingalls. Reports the zinc smelting capacity, and describes the modifications introduced at different works. 3500 w. Eng & Min Jour—Jan. 4, 1908. No. 89426.

MINOR MINERALS.

California.

California Minerals. Arthur S. Eakle. A brief description of the new minerals found, and the date of their discovery. 1800 w. Min & Sci Pr—Jan. 18, 1908. No. 89817.

Diamonds.

Diamond Mining in South Africa. William Taylor. Describes the geological formation and methods of mining. Ills. 2200 w. Mines & Min—Jan., 1908. No. 89334 C.

Lime Burning.

Modern Lime Kilns; the Plant of the Knickerbocker Lime Co., Mill Lane, Pa. Rex C. Wilson. Illustrated detailed description of a large modern lime-producing plant, and its operation. 800 w. Eng News—Jan. 30, 1908. No. 89919.

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Manganese.

Manganese Ores: Their Uses, Occurrence and Production. Gives a résumé of information now available. 6500 w. Bul Imp Inst—Vol. 5. No. 3. No. 89322 N.

Oil.

The Petroleum Industry of the United States. Articles reporting the production in various fields. 6500 w. Eng & Min Jour—Jan. 4, 1908. No. 89407.

Extent and Importance of Oklahoma Oil Fields. Dr. Charles N. Gould. Describes geological features, giving the present production and discussing the possible development. 2000 w. Min Sci—Jan. 16, 1908. No. 89635.

The Location of Bore Holes in Oil Fields (Zur Wahl der Bohrpunkte in den Erdölgebieten). H. Höfer. A discussion of the geological features to be taken into account. Ills. 2000 w. Oest Zeitschr f Berg- u Hüttenwesen—Dec. 14, 1907. No. 89741 D.

Phosphate.

Phosphate Mining in Tennessee. H. D. Ruhm. A report of this industry during 1907, and the present outlook. 1200 w. Eng & Min Jour—Jan. 18, 1908. No. 89619.

Platinum.

See Production, under GOLD AND SILVER.

Sapphires.

Anakie Sapphire Fields, Central Queensland. Information from a recent report of C. F. V. Jackson. Ills. 1200 w. Queens Gov Min Jour—Dec. 14, 1907. No. 89832 B.

Slate.

Slate Mining in Wales and Cause of Its Decline. Discusses the causes of the decline of this industry and gives an illustrated description of the Oakeley mine and its methods. 2000 w. Eng & Min Jour—Jan. 18, 1908. No. 89618.

Sulphur.

Apparatus for Obtaining Sulphur from Furnace Gases. Franklin R. Carpenter. Illustrated description of the writer's sulphur recovery apparatus from the smelting of sulphide ores. 2500 w. Min Wld—Jan. 4, 1908. No. 89365.

Tin.

Notes on Tin. Prof. A. Humboldt Sexton. The present number considers its physical and chemical properties, uses, value; tin minerals and ores, their distribution, etc. 3500 w. Mech Engr—Jan. 11, 1908. Serial. 1st part. No. 89641 A.

Government Tin Prospecting in Transvaal. An encouraging report, taken from an article by U. P. Swinburne. 1200 w. Min Jour—Jan. 4, 1908. No. 89520 A.

The Bolivian Tin Mining Industry and Railways. G. Preumont. An account of the deposits and mines and the railways proposed which will affect their development. 3000 w. Min Jour—Jan. 14, 1908. Serial. 1st part. No. 89519 A.

The Utilization of Tin Scrap (Aprovechamiento de los Recortes de Hojalata). Reviews the various methods for the recovery of tin from scrap and refuse. Serial. 1st part. 3000 w. Ingenieria—Nov. 30, 1907. No. 89706 D.

See also Magnetic Separation, under ORE DRESSING AND CONCENTRATION.

Tungsten.

The Dragoon, Arizona, Tungsten Deposits. Ralph W. Richards. Notes on the occurrence and origin of rubnerite and scheelite ores, the production and development. 1200 w. Min Sci—Jan. 23, 1908. No. 89852.

MINING.

Bore-holes.

The Deviation of Rand Bore-Holes from the Vertical. Discussion of Joseph Kitchin's paper on this subject. 10500 w. Inst of Min & Met, Bul 39—Dec. 12, 1907. No. 89673 N.

Compressed Air.

High vs. Low Pressure for Compound Air in Mines. Robert B. Brinsmade. Discusses the economical limit of pressure, the theory of the intercooler, preheaters, etc. 1500 w. Eng & Min Jour—Jan. 18, 1908. No. 89622.

Costs.

Variation in Mining Costs. J. R. Finlay. Gives a comparative table of working costs, and discusses the considerations that give rise to the wide difference in estimates. 3000 w. Min & Sci Pr—Jan. 4, 1908. No. 89433.

Development Work.

Some Experiences with Exploration Tunnels. Arthur Lakes. Reasons why exploration work should be by sinking and cross-cutting, rather than by cross-cutting at depth and raising. 2500 w. Min Sci—Jan. 2, 1908. No. 89369.

Drills.

Notes on Small Stope Drills. E. M. Weston. Considers some of the reasons for past failures of small drills, describes and illustrates types now used, and their operation. 10000 w. Jour Chem, Met, & Min Soc of S Africa—Oct., 1907. No. 89643 E.

Economics.

False Economy in Mining. M. Mownley. Read before the Nat. Assn. of Col Mgrs. Gives cases from the writer's experience, and discusses details. General discussion. 7000 w. Ir & Coal Trds Rev—Jan. 10, 1908. No. 89663 A.

Electric Hoisting.

The Highest Speed and Time of Acceleration and Retardation in Electric Hoisting with Constant Current (Ermittlung der höchsten Geschwindigkeit, der Be-

schleunigungs- und Verzögerungsdauer elektrisch betriebener Fördermaschinen bei Anfahren und Stillsetzen mit konstantem Strome). Eugen Kulka. Ills. 1600 w. Elektrotech Zeitschr—Dec. 12, 1907. No. 89784 D.

Electric Power.

Electric Power in Coal Mining. An illustrated article discussing its adaptation to pumping, winding, coal cutters, etc. 2500 w. Cassier's Mag—Jan., 1908. No. 89456 B.

Gas-Electric Power at the Mansfield Copper Mines and Smelting Works. Summary of articles by H. R. Speyer, on the present electric equipment of these mining and smelting works. Ills. 2500 w. Elec-Chem & Met Ind—Jan., 1908. No. 89487 C.

See also Montana, under COPPER.

Explosives.

See same title, under COAL AND COKE.

Haulage.

See Tipples, under MINING.

Hoisting.

The Foby Safety Appliance for the Prevention of Overwinding. Illustrated description, translated from *Comptes Rendus*. 500 w. Col Guard—Jan. 17, 1908. No. 89870 A.

Laboratory.

The Laboratory: Its Economic Value. A. McArthur Johnston. Outlines the basis on which laboratory work should be conducted and the methods in use in the Consolidated Gold Fields laboratory. 8000 w. Jour Chem, Met, & Min Soc of S Africa—Oct, 1907. No. 89642 E.

Mine Fire.

The Homestake Mine Fire: Unusual Methods Employed in Fighting It, and the Lessons That It Taught. Bruce C. Yates. Gives a brief description of the ore bodies and method of extracting the ore, with illustrated description of the flooding of this South Dakota mine, its unwatering, etc. 8000 w. Eng News—Jan. 2, 1908. No. 89271.

Quarrying.

Stone: Quarrying and Preparation for Sale. Allan Greenwell, and J. V. Elsden. The first of a series of articles containing information upon matters connected with quarrying. 3000 w. Quarry—Jan., 1908. Serial. 1st part. No. 89534 A.

Reviews of 1907.

Mineral and Metal Production in 1907. Gives statistics of the output of the more important substances. 1200 w. Eng & Min Jour—Jan. 4, 1908. No. 89397.

Review of Mining in Foreign Countries. Gives details of production during 1907 in various parts of the world. 22500 w. Eng & Min Jour—Jan. 4, 1908. No. 89405.

Mining in the United States During 1907. Different authors give reports of progress from various camps. 25000 w. Eng & Min Jour—Jan. 4, 1908. No. 89404.

Shaft Sinking.

Sinking the Clonan Shaft at Mineville, N. Y. Guy C. Stoltz. Describes the conditions and the methods adapted. 1200 w. Eng & Min Jour—Jan. 11, 1908. No. 89477.

Shaft Stations.

See same title, under COAL AND COKE.

Sinking Pumps.

See Pumps, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Stoping.

The Method of Breast Stoping at Cripple Creek. G. E. Wolcott. Illustrates and describes the methods employed at the Portland mine, which require much timber, permit complete extraction, but do not increase the safety. 1400 w. Eng & Min Jour—Jan. 11, 1908. No. 89475.

Tipples.

The Green Self-Dumping Car Haul. Illustrated description of a new system of handling and dumping mine cars. 2500 w. Ir Age—Jan. 30, 1908. No. 89905.

Unwatering.

See Mine Fire, under MINING.

Valuation.

Calculation of Mine-Values. R. B. Brinsmade. An attempt to form a formula by which a mine can be quickly evaluated, after the physical data has been collected. 1500 w. Bul Am Inst of Min Engrs—Jan., 1908. No. 89891 C.

Wages.

The Difficulty of the Wage Question in Mining (Schwierigkeiten des Lohnwesens im Bergbau). Dr. Herbig. A discussion of the various factors to be taken into account in establishing scales of wages. 3500 w. Glückauf—Dec. 28, 1907. No. 89740 D.

Wage Scales in the British and Rhine-Westphalian Coal Fields (Ueber Lohntarife im britschen und rheinisch-westfälischen Steinkohlenbergbau). Herr Hilgenstock. An elaborate discussion of wages, costs, labor conditions and labor troubles in these districts. Ills. Serial. 1st part. 10000 w. Glückauf—Dec. 7, 1907. No. 89736 D.

ORE DRESSING AND CONCENTRATION.

Concentrates.

See Smelter Contracts, under COPPER.

Costs.

See same title, under MINING.

Gold Milling.

Progress in Gold-Ore Treatment During 1907. Alfred James. Fine sliming and the treatment of slimes, improved apparatus, and progress in cyanidation are considered. 2500 w. Eng & Min Jour—Jan. 4, 1908. No. 89401.

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The Question of Ore Concentration. H. P. Dickinson. Considers the limitations of water concentration as compared with fire treatment. 1200 w. Min Sci—Jan. 11, 1908. No. 89636.

See also Hungary and Nevada, under GOLD AND SILVER; and Air Lift, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Magnetic Separation.

The Separation of Tin Oxide from Wolfram. Discussion of the paper by Amos Treloar, and Gurth Johnson. 3000 w. Inst of Min & Met, Bul 39—Dec. 12, 1907. No. 89674 N.

Mills.

The Six-Thousand Ton Concentrator of the Utah Copper Co., Garfield, Utah. R. L. Herrick. Illustrates and describes the machinery equipment and methods of milling. 4000 w. Mines & Min—Jan, 1908. No. 89333 C.

Silver Milling.

See Mexico, under GOLD AND SILVER.

Slimes Treatment.

See Air Lift, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Zinc Milling.

Sludge Concentration in the Joplin District. Doss Brittain. An illustrated explanation of methods used to recover the zinc and lead wastes. 3500 w. Min Wld—Jan. 4, 1908. No. 89364.

MISCELLANY.

Ontario.

Ontario's Mining Progress in the Last Decade. Phillips Thompson. A review of the increase in production, the development work, etc. 2000 w. Can Min Jour—Jan. 15, 1908. No. 89629.

Temperature Gradients.

The Internal Temperature Gradient of Metals. Schuyler B. Serviss. Detailed description of apparatus used, and observations and results of experiments made, comparing with work by Dr. C. B. Thwing. 5000 w. Am Jour of Sci—Dec., 1907. No. 89159 D.

Washington.

Reconnaissance into Okanogan Mountains, Washington. Horace F. Evans. The present article reviews briefly the early explorers of this region, and begins a description of the geology. 2500 w. Min Wld—Jan. 18, 1908. Serial, 1st part. No. 89633.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Signalling.

Overrunning Signals. Mr. Scholkmann. Concerning the tests made on the Prussian State Railway, the devices proposed, etc. 3700 w. Bul Int Ry Cong—Dec., 1907. No. 89507 E.

See also Switches, under PERMANENT WAY AND BUILDINGS.

Signals.

Alternating Current Automatic Block Signals on the Highland Division of the New York, New Haven & Hartford. Illustrated description of the system installed. 1800 w. R R Gaz—Jan. 17, 1908. No. 89588.

See also same title, under STREET AND ELECTRIC RAILWAYS.

MOTIVE POWER AND EQUIPMENT.

Adhesion System.

The Puy de Dome Adhesion Railway. Illustrated detailed description of the special system used on very steep grades, using steam locomotives with supplementary adhesion gear. 3000 w. Engr, Lond—Dec. 27, 1907. No. 89389 A.

Brakes.

Some Defects of the E. T. Brake. G. W. Kiehm. A discussion. 2000 w. Ry & Loc Engng—Jan., 1908. No. 89340 C.

Continuous Brakes and Goods Trains. A. Huberti and J. Doyen. A contribution to the question of drawing up a programme for making goods-train brake trials. 4800 w. Bul Int Ry Cong—Dec., 1907. No. 89503 E.

Car Repairing.

Repairing Steel Freight Cars. Illustrates and describes methods of maintaining and repairing these cars at the McKees Rocks shops of the Pittsburgh & Lake Erie. 2000 w. Am Engr & R R Jour—Jan., 1908. No. 89315 C.

Cycle.

Railway Cycle. A. Honemann. Describes a cycle devised by O. Grasshoff which has given excellent results. Ills. 1700 w. Bul Int Ry Cong—Dec., 1907. No. 89508 E.

Driving Wheels.

The Influence of the Diameter of Driving Wheels. Editorial discussion of Prof. Goss's investigations and the conclusions. 1700 w. Engr, Lond—Dec. 27, 1907. No. 89391 A.

Electrification.

Practical Aspects of Steam Railroad Electrification. W. N. Smith. Discusses the electrification project, and railroad operation. 6000 w. Pro Am Inst of Elec Engrs—Jan., 1908. No. 89325 D.

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Locomotive Efficiency.

The Efficiency of Locomotives in Relation to Their Main Constructional Features and Their Speed (Die Leistungsfähigkeit der Lokomotiven in Abhängigkeit von ihren baulichen Hauptverhältnissen und der Fahrgeschwindigkeit). Albert Frank. Serial. 1st part. 5000 w. Glasers Ann—Dec. 15, 1907. No. 89761 D.

Locomotive Maintenance.

Handling Locomotive Supplies. E. Fish Ensie. Considers the practical care, upkeep, supervision, and economy in the handling of engine equipments. Ills. 1700 w. Am Engr & R R Jour—Jan., 1908. No. 89316 C.

Locomotives.

Four-Wheel Switch Locomotive for the Burden Iron Company. Illustrated description. 400 w. Ry Age—Jan. 3, 1908. No. 89362.

Shay Locomotive for the Southern Railway. Illustrated description of engines used on heavy grades. 300 w. Ry Age—Jan. 3, 1908. No. 89363.

Locomotive with Water-Tube Fire-Box. Illustrated description of engine fitted with a Brotan fire-box. 500 w. Engr, Lond—Jan. 10, 1908. No. 89661 A.

Types of Compound Locomotives. Explains the action of the compounds most commonly used. 1200 w. Ry & Loc Engng—Jan., 1908. No. 89341 C.

Pacific Locomotive for the Lake Shore. Illustrated description of two types of heavy passenger engines. 1000 w. Ry Age—Jan. 24, 1908. No. 89849.

Simple Prairie Type Locomotives. Illustrated description of engines for freight service on the Wabash R. R. 600 w. Am Engr & R R Jour—Jan., 1908. No. 89320 C.

Simple Consolidation Locomotive. Illustrated description of Class D, heavy locomotives built for the C., N. O. & T. P. Ry. 700 w. Am Engr & R R Jour—Jan., 1908. No. 89319 C.

The British Locomotive. A. W. S. Graeme. Read before the Rugby Engng Soc. Explains conditions in Great Britain which influence the design of locomotives, describes types used, and briefly explains why compounding is not economical under present conditions. 5500 w. Mech Engr—Jan. 18, 1908. No. 89862 A.

Italian 4-Cylinder Compound Double-Ended Locomotive. Illustrated detailed description of engines adapted for express and freight service upon the steepest grades in mountainous regions. 1500 w. Ry Age—Jan. 17, 1908. No. 89627.

Recent Improvements in the Rolling Stock of Italian Railways (Le Recenti Migliorie nel Materiale Rotabile delle Ferrovie Italiane). Luigi Greppi. Describes principally new types of locomotives, illustrating with detailed plates. Ills. 10500 w. Ann d Soc d Ing e d Arch Ital—Nov.-Dec., 1907. No. 89701 F.

A Comparison of the Two- and Three-Coupled High-Speed Locomotives of the Prussia-Hesse State Railways from a Theoretical Point of View (Ein Vergleich der zwei- und dreigekuppelten Schnellzug-Lokomotiven der preussisch-hessischen Staatsbahnen auf Theoretischer Grundlage). J. Zillgen. Ills. Serial, 1st part. 4500 w. Glasers Ann—Dec. 15, 1907. No. 89760 D.

See also Steam vs. Electricity, under MOTIVE POWER AND EQUIPMENT.

Motor Cars.

Gasoline-Electric Motor Car for Delaware & Hudson Railroad. Illustrated description of the car and its operation and equipment. 2500 w. St Ry Jour—Jan. 25, 1908. No. 89827.

Shops.

A Few Locomotive Tools and Fixtures. L. E. Salmon. Illustrates and describes special appliances used on railroad work which save time and money. 2300 w. Am Mach—Vol. 31. No. 3. No. 89562.

Arrangement of Railroad Shops. George A. Damon. Read before the Canadian Railway Club. Considers the design, arrangement, and equipment of repair shops from a financial standpoint. Plans. 5000 w. R R Gaz—Jan. 10, 1908. No. 89445.

New Freight Car Repair Shops of the Santa Fé. Illustrations, with description of new shops at Topeka, Kan. 1500 w. R R Gaz—Jan. 17, 1908. No. 89586.

See also Car Repairing, under MOTIVE POWER AND EQUIPMENT; and Steel Buildings, under CIVIL ENGINEERING, CONSTRUCTION.

Steam vs. Electricity.

Electric Working on Standard-Gauge Lines with Steep Gradients. Mr. Mühlmann. Shows that electric working cannot yet compete financially with steam-working. 4500 w. Bul Int Ry Cong—Dec., 1907. No. 89506 E.

Discussion on "Comparative Performance of Steam and Electric Locomotives," at New York, Nov. 8, 1907. Paper of Albert H. Armstrong. 6500 w. Pro Am Inst of Elec Engrs—Jan., 1908. No. 89899 D.

Valve Gears.

Walschaert Valve Gear. Illustrated description of a design being applied by the Canadian Pacific Ry. 1000 w. Am Engr & R R Jour—Jan., 1908. No. 89317 C.

Wheels.

The Car Wheel. George L. Fowler. Gives an illustrated account of investigations made under the auspices of the Schoen Steel Wheel Co. Also general

We supply copies of these articles. See page 1103.

discussion. Ills. 11500 w. Pro Ry Club of Pittsburgh—Nov., 1907. No. 89683 C.

Comparative Physical Tests of Car Wheels and Tires. George L. Fowler. Report of tests and results, reprinted from report made to the Schoen Steel Wheel Co. 2000 w. R R Gaz—Jan. 3, 1908. No. 89343.

Microphotographs of Steel Wheels and Tires. George L. Fowler. Illustrations and report of examinations with the microscope of sample wheels tested by the Schoen Steel Wheel Co. 2000 w. R R Gaz—Jan. 24, 1908. No. 89840.

NEW PROJECTS.

Alaska.

The Most Wonderful Railroad of the North. Katherine Louise Smith. Illustrated description of the White Pass and Yukon Railway, and its construction. 1500 w. Sci Am—Jan. 11, 1908. No. 89449.

Austria.

The New Austrian Alpine Railways. Map, plate, illustrations, and description of new lines to give more direct communication with the port of Triest. Many interesting engineering features. 4000 w. Engr, Lond—Jan. 17, 1908. No. 89872 A.

Bolivia.

See Tin, under MINING AND METALLURGY, MINOR MINERALS.

Central America.

A Central American Railway. Theodore Paschke. Urging the construction of an Intercontinental Railway from Mexico to Panama, discussing the line and method of procedure. 2800 w. Eng Rec—Jan. 18, 1908. No. 89612.

Yosemite Valley.

The New Yosemite Valley Railroad. L. E. Danley. An illustrated description of a line through this famous region, and the interests it will serve. 1000 w. Ry Age—Jan. 24, 1908. No. 89850.

PERMANENT WAY AND BUILDINGS.

Construction.

Railroad Construction in Western Montana. John C. Breedlove. Mainly a description of extensive work on the Northern Pacific Ry. 1800 w. Cornell Civ Engr—Jan., 1908. No. 89903 C.

Construction of the Guelph & Goderich Railway. J. Grant MacGregor. Illustrated description. 1300 w. Eng Rec—Jan. 18, 1908. No. 89616.

Grade Reduction.

Grade Revision on the Canadian Pacific Railway in British Columbia. Brief account of important work in progress on the steepest part of the road. Ills. 1000 w. Eng News—Jan. 23, 1908. No. 89805.

Improvements.

The Pennsylvania Railroad Improvements at Blairsville, Pa. G. W. Phillips, and J. Gwilliam. Illustrated description of a change of line about 9 miles long from Blairsville to Tunnelton, Pa., costing about $2,500,000. 2800 w. Eng Rec—Jan. 4, 1908. No. 89355.

Rails.

The Present Status of Rail Specifications. A review of the action taken by the American Railway Assn. 2000 w. Ry Age—Jan. 17, 1908. No. 89628.

Stations.

New Station at Sydney, N. S. W. Illustrates and describes new station buildings and arrangements for handling heavy traffic. 2500 w. Engr, Lond—Dec. 27, 1907. No. 89390 A.

The New Station at Stuttgart. Plans and description of proposed alterations. 1700 w. Bul Int Ry Cong—Dec., 1907. No. 89505 E.

Switches.

New Interlocking Plant, Hoboken Terminal Yard, Delaware, Lackawanna & Western Ry. Illustrated detailed description of a plant possessing novel features tending to greater safety and dispatch. 4500 w. Eng News—Jan. 30, 1908. No. 89925.

Ties.

See Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Yards.

The New Shunting Yard at Wath, in England. Mr. Frahm. Plan and description. 1100 w. Bul Int Ry Cong—Dec., 1907. No. 89504 E.

TRAFFIC.

Europe.

Observations on European Railroads, Including Freight House and Freight Office Work. Albert T. Perkins. Illustrates and describes typical team-yard and freight-house arrangements, methods of work, etc. 2000 w. Pro St Louis Ry Club—Dec., 1907. No. 89461.

Freight Sheds.

See Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

MISCELLANY.

Canada.

The Railroads of Canada. J. L. Payne. Information concerning the growth of the railroad system, earnings, betterment, operation, etc. 4000 w. R R Gaz—Jan. 24, 1908. No. 89841.

Coal Lands.

Railway Coal Properties Under the Hepburn Act. Shows some of the problems arising from the Act to be solved by lawyers and the law department of the government. 4500 w. Ry Age—Jan. 3, 1908. No. 89361.

We supply copies of these articles. See page 1103.

STREET AND ELECTRIC RAILWAYS

Adhesion System.

A Mountain Electric Railway. Frank C. Perkins. Illustrated description of a railway to the summit of the Altenberg. A combined adhesion and rack railway. 700 w. Sci Am Sup—Jan. 18, 1908. No. 89576.

Cars.

Novel Car Used in Troy, N. Y. Illustrated description of a car practically without platforms, which cannot be boarded after the doors are closed. 1000 w. St Ry Jour—Jan. 18, 1908. No. 89607.

The Best Design of Car for Suburban Traffic at Melbourne. Thomas Tait. Presents the disadvantages of the type of cars in use and suggests desirable changes. 1700 w. R R Gaz—Jan. 17, 1908. No. 89589.

Conduit System.

The Conduit System of Electric Tramway Construction and Recent Improvements. Fitz Roy Roose. Read before the Jun. Inst. of Engrs. Compares the original method of construction of the conduit system with that at present in vogue. Ills. 1400 w. Elec Engr, Lond—Jan. 17, 1908. Serial. 1st part. No. 89865 A.

Double Traction.

The Colonna Double Traction System for Tramways (La Double Traction Electrique des Tramways Système Colonna). J. A. Montpelier. Illustrates and describes a simple double traction system in use at Naples which avoids the expense necessary to equip cars with multiple-unit control apparatus. 2300 w. Electricien—Dec. 14, 1907. No. 89721 D.

Electrification.

See same title and Steam vs. Electricity, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Interurban.

See Single Phase, under STREET AND ELECTRIC RAILWAYS.

Locomotives.

Electric Locomotive for Passenger and Freight Service; Metropolitan Railway, of London. Illustrated detailed description. 1500 w. R R Gaz—Jan. 17, 1908. No. 89585.

Motors.

See Railway Motors, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Power Plants.

See Central Stations and Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Rack Railways.

See Adhesion System, under STREET AND ELECTRIC RAILWAYS.

Shops.

Anderson Shops of the Indiana Union Traction Company. R. C. Taylor. Illustrated detailed description. 2000 w. Elec Ry Rev—Jan. 18, 1908. No. 89637.

Signals.

Signals for Trolley Car Lines. Illustrates and describes the signal systems for trolley car lines in America and England. 2500 w. Tram & Ry Wld—Jan. 12, 1908. No. 89555 B.

Single Phase.

Single-Phase Equipment of the Windsor, Essex & Lake Shore Rapid Railway. S. C. DeWitt. An illustrated description of the construction and operation of this line in Canada. 3000 w. St Ry Jour—Jan. 11, 1908. No. 89480.

Subways.

Fires on Underground Electric Railways. Briefly discusses this matter especially as regards London underground railways, showing that every effort has been made to guard against danger. 2000 w. Engr, Lond—Jan. 17, 1908. No. 89874 A.

The Project for Underground Railways as a Solution for the Traffic Problems of Berlin (Der Entwurf unterirdischer Strassenbahnen in Berlin und die Berliner Verkehrsfrage). E. C. Zehme. An illustrated, description of the plan. 2300 w. Elektrotech Zeitschr—Dec. 19, 1907. No. 89787 D.

Systems.

A Critical Study of the Various Systems of Electric Traction (Etude Critique des Différents Systèmes de Traction Electrique). Ills. 9000 w. Soc Belge d'Elec'ns Dec., 1907. No. 89708 E.

Track Bonding.

Bonding. E. Goolding. Discussing the effect of bonding on the resistance of tracks used for return current, giving diagrams for measuring the resistance. 700 w. Tram & Ry Wld—Jan. 2, 1908. No. 89556 B.

Track Construction.

A Comparison of Substructures for Tracks in Streets. H. L. Weber. Illustrates and suggests track schemes for lessening cost and lengthening the life of good tracks. 1200 w. Elec Ry Rev—Jan. 25, 1908. No. 89853.

Track Reconstruction in San Francisco. Illustrates and describes interesting track work carried out since the earthquake. 1200 w. St Ry Jour—Jan. 18, 1908. No. 89606.

Trolley Wires.

See Protective Devices and Wire Suspension, under ELECTRICAL ENGINEERING, TRANSMISSION.

We supply copies of these articles. See page 1103.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Science. *w.* Denver, U. S. A.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zurich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

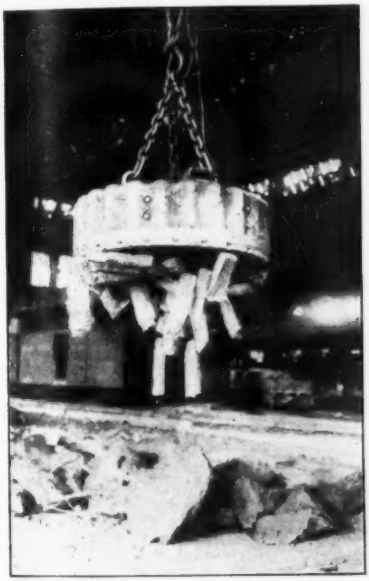
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Lifting Magnets.

AFTER several years of preparation the Cutler-Hammer Clutch Co., Milwaukee, Wis., have placed their magnets on the market. They can be furnished in any size, from a 10-inch magnet for lifting plates, rails, small castings, etc., up to a 50 or 52-inch magnet designed for handling pig iron, scrap, etc., and capable of lifting a ten-ton "skull-cracker."



The Cutler-Hammer lifting magnets are designed by engineers who for years have devoted themselves to problems involving electric and magnetic control.

Under rigid service tests the records established by Cutler-Hammer magnets have been so satisfactory that they are selling magnets under a "Three-Way" guarantee. (1) The magnet will be as light as is consistent with proper design and its weight will be guaranteed *not to exceed* that of any comparable magnet; (2) The lifting capacity of the magnet will be guaranteed to exceed that of any comparable magnet now in use. (3) The operating cost per ton of material moved will be guaranteed to be less than with any comparable magnet.

The lifting magnet is of particular value wherever pig iron, metal plates, tubes, rails, beams, scrap or heavy castings of iron or steel are handled. The time saved due to the fact that hoisting tackle need not be adjusted to the object to be raised is of itself often sufficient to justify the purchase of a lifting magnet. For handling pig iron, scrap and similar material a

further advantage is found in the fact that the objects to be moved need not be piled beforehand. All that is necessary in work of this sort is to lower the magnet onto the pigs or scrap, switch on the current—

and lift. In foundries and rolling mills magnets are useful for lifting and transporting metal too hot to be touched with the hand.

The Cutler-Hammer Clutch Co. have issued an interesting illustrated booklet about lifting magnets which they will send on request.

Test of Concrete Blocks.

THAT concrete blocks properly made are capable of withstanding enormous crushing strain is borne out in the following tests made by Professor Crocker of the Mechanics' Institute, Rochester, N. Y. A block made on the Hercules machines by Palermo Bros., Mount Morris, N. Y., containing 126 square inches, total area (net area, deducting air space, 100 square inches) crushed at 181,000 lbs., which is equivalent to 1,436 lbs. per square inch total area, and 1,810 per square inch net area. A second test was made with a block 8 x 12 x 24 produced on a Hercules machine operated by J. F. Norris, Brighton, N. Y. This block was subjected to 200,000 lbs. crushing test and refused to break. The limit of the testing apparatus having been reached, it was impossible to learn how much additional weight would be required to break the block. The two blocks submitted were regular stock blocks made of good material mixed with two-to-one facing and a five-to-one backing. According to Hercules methods a sufficient amount of water had been used when the blocks were made to insure perfect chemical action.

Otis Feed Water Heater.

THE main object of the Otis feed-water heater is to heat thoroughly the feed water by the exhaust steam before it enters the boiler; to separate mud and sediment from the feed water and remove it easily and quickly from the heater; to collect and carry off the scum from the surface of the water and to collect and carry off the condensation and oil from the exhaust.

The body or shell of the heater is made of boiler iron or steel, the top end of which is riveted to a heavy cast iron ring, with a projecting rim cast upon its outer surface, forming a flange, to which the tube sheet and top dividing plate is attached by one row of bolts. The lower end of the shell is riveted to a heavy cast iron conical bottom, which is supported by four legs, making a substantial base for the heater.

In operating the heater the exhaust steam enters the heater at the top, as shown in cut, passes down one section of tubes into the enlarged space of the water and oil catcher, where the water of condensation and oil are separated, and the exhaust steam then passes up through the other section of tube, thus passing twice through the entire length of the heater, heating the feed water to the boiling point.

The exhaust steam can then be used for other purposes or exhausted into the atmosphere. The water enters the heater near the bottom, and passing upwards in contact with the heated tubes, gradually becomes thoroughly heated, and is discharged as near the top as practicable without carrying the scum that is on the surface of the water into the boiler.

The Otis heater is made by the Stewart Heater Co., Buffalo, N. Y., who will furnish fuller details on request.

The Swartwout Ventilator.

THE Swartwout ventilator illustrated herewith is equipped with a conical damper which overhangs the edge of the flue making it absolutely weatherproof when closed, and preventing any dust from shaking down and re-entering the building when it is opened. This damper is mounted upon a heavy iron sleeve and slides up and down on a rod, which prevents catching or binding.

It closes by gravity, and is raised by means of a chain passing over a specially

made cast iron pulley, the housing of which is firmly secured to the rod guiding the damper. When the damper is shut this pulley and the working parts are enclosed and protected from the weather.

This ventilator is absolutely weather proof and noiseless under all conditions, and is guaranteed. Swartwout ventilators are made with or without dampers. Manufactured by the Ohio Blower Co., 45-49 Michigan Avenue, Cleveland, Ohio, who will furnish fuller details on request.

About Graphite Lubrication.

ALTHOUGH the excellence of graphite for all sorts of lubrication and its particular adaptability to certain difficult lubrication is a matter with which most of us are familiar, few, perhaps, are cognizant of the fact that there are two forms of graphite—flake, or foliated, and amorphous, or nonstructural, graphite—and that though chemically the same the latter is capable of finer pulverization and with careful treatment may be reduced to an impalpably fine powder absolutely free from grit or any sort of harmful impurity. Flake graphite on the other hand, no matter how finely pulverized, always retains its original mica-like or crystalline structure and, comparing one with the other, there is a vast difference in nature, texture, action and effect.

In the first place amorphous graphite is *adhesive* in the highest degree. It stays put, and adhesiveness is one of the first requisites of an efficient lubricant in that to cool a hot bearing it is absolutely essential that the lubricating agent "stay put" where applied. To illustrate: Take a pinch of finely pulverized amorphous graphite and rub same in the palm of the hand, on paper or on some other convenient surface and observe its action.

Note that the more one rubs the more effective the lubrication, for this form of graphite is not easily removed from surfaces in frictional contact but maintains constant and effective duty right at the point of contact and is at its best under *heavy frictional pressure* in that as above stated it is adhesive in the highest degree—"stays put"—and there is absolutely no waste as every particle is an active lubricating factor.

Then, too, as an impalpable powder it readily and quickly penetrates and distributes itself in a smooth, slippery, even coating between the tightest bearings, filling every pore, crevice and interstice, thereby evening irregular bearing surfaces and reducing friction to a minimum.

Let us also see how, mixed with lubricating oils, this amorphous graphite will minimize friction.

A microscopic examination of perfectly smooth bearings—cylinder surfaces for in-

stance—will disclose many minute irregularities, which, in the nature of things, must be productive of more or less friction. This friction of course means wasted energy—energy that instead of being utilized as power is absorbed as heat—a condition that more often than not means an overheated bearing with the consequent loss of time and temper. To effectively overcome this friction and utilize this otherwise wasted power, a lubricant possessing considerable "body" is required—that is a *substantial* lubricant of such a nature as to eliminate as far as possible these microscopical irregularities and provide a bearing offering minimum resistance to the surfaces in play.

Experience, which is man's teacher, has not only demonstrated time and again that oil in itself will accomplish this only to a certain extent, but it has also taught that pure soft finely *powdered* graphite, properly and judiciously applied, will do wonders, so it only remains to make the proper application of the right sort of graphite. It has, therefore, long been the endeavor of intelligent engineers to secure a graphited oil, that is to say, an oil in which graphite floats or is held in suspension without precipitation, sufficiently long to perform its duty, for it is easy to see the great advantage to be derived from the use of an oil having every drop impregnated with solid lubricating matter.

This seemingly simple problem, however, is one that has until lately baffled engineers of experience, but it has now been found that amorphous graphite when reduced to an impalpably fine powder will, when mixed with oil in the proportion of about one teaspoonful to the pint of oil, remain in perfect suspension long enough to feed through lubricator tubes without clogging, thus causing every drop of oil to carry its mite of graphite. The United States Graphite Co., Saginaw, Michigan, prepares a lubricating graphite of this description.

Carbolineum Combination Process.

A PAPER prepared by C. S. McKinney presents some useful information on wood decay and preservation. Mr. McKinney points out that the cause of the decay of wood is the growth in it of a microscopic fungus which flourishes under certain conditions of heat, moisture and air. Excluded from the air, as when completely buried in water, wood will remain sound for ages—hence piles, as foundations for buildings, driven into the ground "below the water line," do not require preservative treatment.

Wood is composed of fiber and cellular tissue. The fiber is quite durable and, by itself alone, resists the attack of decay germs, but the cellular tissue, composed largely of albuminous substances, which act as soil and sustenance for the decay organisms, soon breaks down, involving the destruction of the whole substance of the wood. Therefore to protect wood from decay the cellular tissue must be protected from the invasion of the decay germs, or it must be so altered by chemical change that it will no longer be a suitable medium of germ culture.

It was long ago discovered that certain chemicals had the property of protecting wood from decay, but the trouble has been to bring them into sufficient contact with the cellular tissue of the wood and then to make the contact a permanent one. To this end the substance used must not evaporate at ordinary temperature nor be soluble in water, hence aqueous solutions of antiseptic chemicals will not avail when the treated wood cannot be protected from moisture; neither will the light oils give more than temporary protection, even when combined with the powerful antiseptic coal tar acids, for, in a short time, they evaporate and the temporary protection ceases. It therefore follows that the heavy oils, insoluble in water, which do not evaporate at ordinary atmospheric temperatures, combined with powerful chemicals, which are both antiseptics and germicides, must be the ideal and rational process of preserving wood. There is no doubt about the efficiency of such a combination, for nearly a century of experience has proved it. The obstacle to the general use of this method is the difficulty of forcing enough of the preservative into the wood to protect it and the expensive machinery for doing this, skilled labor and transportation of the wood long distances, to and from the treating plant, makes the

expense of the process prohibitory in most cases.

To get a preservative which can be successfully applied to the wood at the place of use without expensive machinery has been the great desideratum.

Various combinations have been employed. Some have proved worthless, others have shown excellent results in some cases and complete failures in others, much depending on the nature, kind and condition of the wood to which the preservative is applied. For example, an open grained, soft wood will readily absorb a heavy oil of considerable viscosity and be greatly benefited; whereas a close grained, hard wood could absorb little or almost none of such a preservative, hence the treatment would be a failure. Different woods require preservatives of different penetrating properties. Now the most penetrating, within certain limits, are less persistent than the heavier and less penetrating grades, hence, if they only are used, the wood is less permanently protected.

In the Carbolineum Combination Process, the wood is first treated with a very light, penetrating Carbolineum, containing a large percentage of those antiseptic chemicals which are most efficient in sterilizing the wood, but are not durable in their effects. This first treatment expels the moisture, coagulates the albumen, and prepares the cellular tissue for a better absorption of the second treatment of heavier and more persistent material. By this combination method a deeper, more efficient and more durable treatment can be easily secured, and at a relatively much less cost than where only a single grade Carbolineum is used, even when it is the highest grade.

Mr. McKinney's address is 60 Wall street, New York, and he will be pleased to furnish further data on this subject to any inquirer.

Dallett Automatic Hose Couplings.

THE remarkable development during the last few years in the application of compressed air in various industries has, of course, had the effect of stimulating the ingenuity of manufacturers of fittings used in connection with pneumatic tools—especially hose couplings. Up to the present time hose couplings have been found to have vital defects after being put to hard service for a longer or shorter length of time. Some were inordinately expensive to start with, others were frail in construction and their life consequently short, and the fault common to them all was that they would not stay tight. The Thos. H. Dallett Co., Philadelphia, has made a continuous series of experiments and tests on hose couplings for the past four years and we illustrate herewith their new coupling. The cuts show the two halves of a Dallett "hose-to-hose" coupling and the gasket used. The gasket of the Dallett coupling is of a rubber composition, which will not be affected by oil or gasoline, and is held in the female half of the coupling by the flange around the larger end fitting into a recess.

It is impossible for this gasket to fall out or be lost when the coupling is disconnected, and, when necessary, a new gasket can be inserted in a few seconds. When the coupling is connected, the tapering end of the gasket enters into the conical opening in the male part and is a loose fit therein. When pressure comes on the coupling this tapered end of the gasket is expanded against the wall of said conical opening, making a perfect joint, which the greatest pressure will only make the tighter, and as soon as the pressure is relieved, the gasket is again loose, so that no matter how long a coupling may remain connected, it will not adhere to the metal and be torn and ruined in the coupling being taken apart.

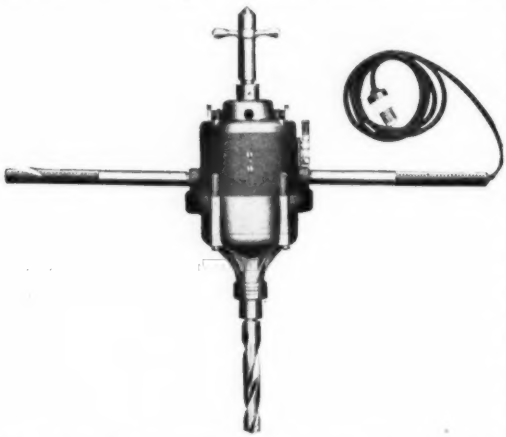
As will be noted, the male part of the coupling is provided with four locking-lugs, equally spaced around its circumference, and when the male and female parts are snapped together, these lugs insure their being held squarely; which obviates the tendency to leak common in other couplings of this class, especially those provided with only two lugs. To connect the Dallett coupling, simply press the parts together, give one-eighth of a

turn and the locking-ring will spring into place. It is then a physical impossibility for it to be puled apart or accidentally disconnected. When the connection is to be broken, press back the locking-ring and give the coupling one-eighth turn.

The entire coupling is made of a very hard bronze composition, has no small parts to give trouble, and no projecting pieces to catch when the hose is trailed along the ground. The locking-ring is provided with a milled ridge around its circumference which affords a good grip for pressing it back when disconnecting the coupling and so stiffens and strengthens it that it requires extraordinary abuse to spring or bend it so as to impair the working of the coupling.

Hisey Portable Electrical Screw-Feed Drill.

WE illustrate herewith a new type electrical drill, made by the Hisey-Wolf Machine Company, Cincinnati, Ohio, and which they are just putting on the market. It is made in two sizes, 7/8" capacity, weight 27 lbs., and 1¼" capacity, weight 38 lbs. These capacities as given are for steel. Larger size holes can be drilled in softer material. The driving power is obtained from the ordinary incandescent lamp socket.



The motor is full enclosed at the spindle end, preventing borings or chippings entering in any way. The switch is located on the body of the motor within immediate reach of the operator. The two side handles are detachable. An "old man" is furnished as an extra if desired. The gears and working parts are hardened. All parts are easily accessible for adjustment and at the same time protected in every way. This drill is simple, durable and compact, with no complicated parts to get out of order. It is especially built for the heavy work for which it is intended. These electrical drills are particularly useful in machine shops, boiler plants, bridge building, construction work and shipyards. They can be carried anywhere, as any length cord can be attached. Hand drills in smaller capacities and Scotch drills up to 2" capacities, are also made by the same company, who will furnish details on application.

Evaporative Test.

THE International Salt Company have used for a number of years in their boiler-plant at the Retsof Mines, Retsof, N. Y., standard internally fired Fitzgibbons boilers, which displaced a battery of horizontal tubular boilers formerly used. The coal burned was Western Pennsylvania semi-bituminous. In building their large plant at Ludlowville, N. Y., and later at Watkins, N. Y., it was necessary to adapt Fitzgibbons boilers for burning very small sizes of anthracite coal as this could be delivered much cheaper from the anthracite mines of Pennsylvania than semi-bituminous coal. Special Dutch-oven extension furnaces were designed with large grate surface, and fitted with McClave grates and steam-blowers. The chimney at Ludlowville was 175 feet in height, and it was found unnecessary to use the steam-blowers, as nearly 30 per cent. in excess of the rated horse-power of the boilers could be obtained with natural draught, and with very extraordinary results, as shown in the evaporative test printed herewith, made by S. C. Smith, M.E.:

Duration of trial	8 hours
Weight of coal as fired	10,000 lbs. wet
Moisture in coal	937 "
Coal burned corrected for moisture	9,063 "
Weight of ash	1,155 "
Water evaporated, total-weight, wet coal, actual conditions	82,017 "
Equivalent water evaporated into dry steam, from and at 212 degrees	89,416 "
Coal consumed per hour	1,133 "
Water evaporated per hour.	10,252 "
Water evaporated per hour from and at 212 degrees..	11,177 "
Boiler pressure by gauge..	61.75 "
Temperature of feed water entering boiler	186.6 "
Horse Power developed, from and at 212 degrees.	323.87 "
Percentage of builders rated HP developed above their rating	29.5%
Water actually evaporated per pound of coal	8.2 "
Equivalent evaporation from and at 212 degrees per lb. of coal as fired	8.94 "
Equivalent evaporation from and at 212 degrees per lb. of combustible	11.42 "
Quality of steam, dry steam being taken as unity	.99964

Coal, Lehigh Valley Rice, Wet and contained considerable bone, slate and dirt.

Ransome Water Tool Grinder.

THE Ransom Mfg. Co., Oshkosh, Wis., have recently placed on the market a new water tool grinder. In this grinder the water is retained in the larger compartment of the tank from which it is forced by means of a blower. In connection with the blower there is no packing and no wearing surface below the water line. The connections with the blower and the place above the emery wheel where the water is deposited is made by means of rubber hose, instead of the gas pipe often used. The advantage of the hose is that it can be quickly cleaned, as it only has to be pulled off, whereas gas pipes have to be screwed together and often have packed joints.

The hood or guard around the wheel is so constructed that all water is brought to the exact spot where it is required in grinding. The rest is perforated so that the water shoots down through it instead of hitting the top of the rest and spattering over the edge of the bowl. On account of the peculiar construction of this rest it is unnecessary to have a big awkward bowl intended to catch the water, but which seldom does. After going through the rest the water is deposited in the settling pan, which is the smaller compartment of the tank, and from there it flows over the partition to the large compartment.

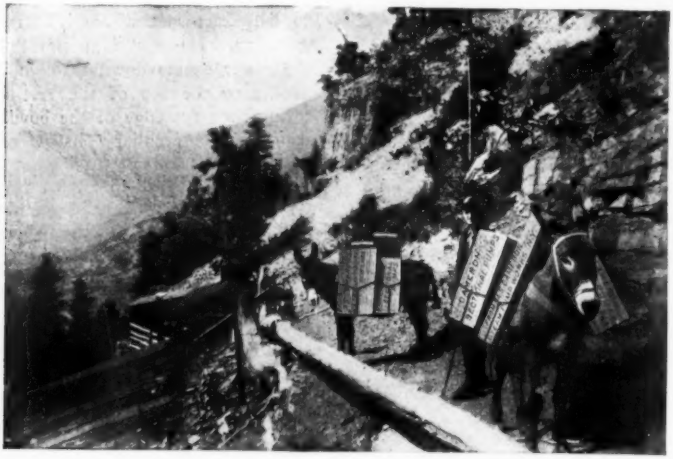
When cleaning becomes necessary the tank which has all the sediment can be taken out doors and cleaned readily. This is better than scraping around with a crooked iron through a hole in the machine in an effort to get the sediment out onto the shop floor.

The water is on the wheel only when it is running. Bearings throughout including countershaft are self-oiling. All shafts, including the countershafts, are ground. An emery wheel dresser can be instantly attached without removing the rests. Arbors are made of 50 point carbon open hearth steel. The countershaft has an improved belt shifter so that the belt is shifted by giving a half turn to the handle. The size of emery wheel is 20 x 1½ inch, and the complete machine weighs 800 lbs.

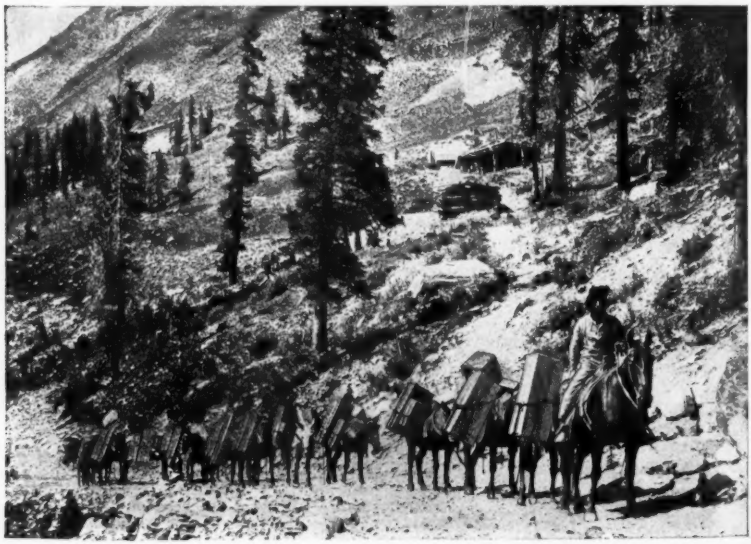
Transporting Milling Machinery in Mountainous Countries.

AMERICAN capital is being constantly invested in the many promising enterprises throughout Mexico, Central and South America. Only recently the United States Consul-General of Mexico estimated that during the last four years $125,000,000 of American capital had been invested in the mines of Mexico alone, while in other industries the investments are also very large. This is also true of the other countries referred to. The greatest percentage of capital, however, is invested in the mining industry; as indeed it was owing

to the discovery of precious metals in the various parts of these countries that led settlers to discover the other resources; thus, new settlements, mining camps and towns were created and are growing rapidly with the new industries. In the development of all of these industries, there is a constant demand for new machinery and equipment, and the larger portion is being supplied by American manufacturers. In the interior and in the mountainous districts, there are still a large number of mining camps without close railroad facilities, and in some places settlements are



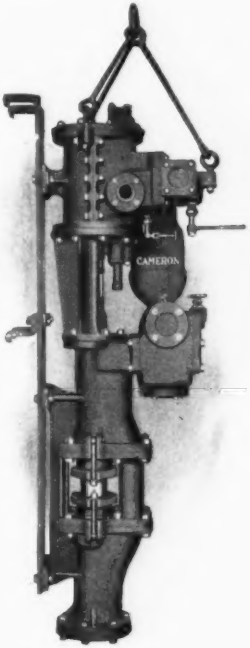
TYPICAL MEXICAN "BURRO" LOADED WITH CAMERON SECTIONALIZED PUMPS.



MULE TEAM CROSSING THE ROCKY MOUNTAINS.

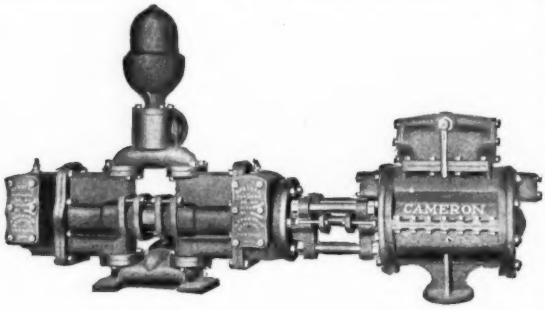
many miles from a railroad station. Transportation facilities are frequently very costly and the methods in many places are very crude. In some parts the transportation of merchandise and machinery is carried on by the use of ox-carts, although in Western Mexico, where the mining industry is extensive, the Mexican burro, or donkey, is a most important factor, and is preferred on account of its being a swifter carrier, and safer in the dangerous mountain passes. Thus the traffic between the railroad stations and the interior points is very largely handled by burro transportation. These little animals are worth from $12.50 to $20 each, United States currency. They average about 500 pounds in weight, and will carry weights up to 300 pounds, traveling from 20 to 40 miles per day, according to the condition of the country.

The class of machinery used in these mining countries is often specially built to suit the mode of transportation, and in order to transport by mule teams must be designed and built to allow for dismantling, so as to form a load of moderate weight for these animals to carry. We are showing herein, by courtesy of the A. S. Cameron Steam Pump Works, two photographic reproductions of mule teams loaded with sectionalized Cameron pumps. These designs of pumps have been adopted almost exclusively for the mountainous regions, and have found their way on mule back, and sometimes by more primitive modes of transportation, over the mountain passes and terraced ranges of our own country and old Mexico, Colombia, Peru and Chili, as well as into other mining regions of Central and South America. These types of Cameron mine pumps are built for the heavy work and rough service which they are usually subjected to in mining work. They are built in sections, the parts being so designed and proportioned that the pumps can be taken apart at the bolted joints, and packed for shipment. The majority of pieces weigh less than 150 pounds, while the maximum weight, 300 pounds, is rarely found, and only in the larger sizes. The parts are so arranged and marked that they can be readily assembled and the pump set up without the aid of a skilled mechanic. The Cameron shipments from New York, destined for long journeys, are arranged for convenient handling and strongly and securely boxed, on account of the numerous transfers of freight in steamship and railroad traffic before they reach their ultimate destination. The arrangements for mule-back transportation must usually



be made at some convenient station on the line of a railroad or other carrier, the cost for transporting the material by burro train varying in proportion to the distance to be traversed, scarcity of animals, and the character and conditions of the country. Where the mountain passes to be traversed are narrow and dangerous, the loads are lightened as much as possible—oftentimes the boxes being discarded and the machinery fastened on the back of the mule or carried in bags. It is sometimes necessary, when crossing steep and narrow mountain passes to strap sticks to both sides of two mules, and place the load between them. The burro is also an

important factor in connection with the mining industry as an ore carrier, and burro trains are loaded up at the mines for



return trips, thus taking material to and fro, the ore being held in leather pouches or bags.

Barth's Gear Slide Rule.

KOLESCH & CO., 138 Fulton Street, New York, are placing on the market the Barth gear slide rule, a device for computing the strength of gear wheels in accordance with the formula,

$$W = \frac{600}{600 \times 2} SPfy,$$

given by Wilfred Lewis in his work on "Investigation of the Strength of Gear Teeth." This is a most complete instrument, embodying directly all the variables of the formula and thus solving them in a way purely mechanical. All the information required for the solution of problems in the strength of gearing when the working strength of the material is assumed or known is condensed within the compass of a small disc of cardboard. No reference tables or diagrams are needed in its use, and it will undoubtedly prove invaluable to designers and draftsmen who have occasion to proportion gearing to the work required of them.

Black Enameled Wire.

FOR a long time the users of magnet wire have realized that the standard method of insulating wire by means of a single or double covering of cotton or silk has many serious drawbacks. Especially in the case of the finer sizes, particularly Nos. 24 to 40, B. & S. gauge, the space occupied by the insulation in comparison with the copper is a serious factor, which increases very rapidly as the size of the wire diminishes, so that in the case of some of the very fine sizes, from 25% to 75% of the available space on a magnet may be taken up by the insulation on the wire, thus reducing the effectiveness of the magnetic winding. Another and still greater objection, especially to silk or cotton insulation, is the fact that while these materials when dry are not conductors of electricity, in a moist atmosphere their tendency to take up moisture reduces their value as insulators and permits the current to leap across, so that the magnet will be put completely out of commission. During the past four or five years The Western Electric Co., Chicago, Ill., has been developing an insulated wire which they call Black Enameled Wire, and which meets the conditions found in practice in a satisfactory manner, and which can be manufactured on a commercial scale. It has been used on their own apparatus during the past four years with very gratifying results, and they are now selling this wire in the open market. The enameled insulation is an elastic yet resistant and firmly adhering film which is applied to wire by specially constructed machinery of their design. The insulation is exceedingly inert toward the ordinary agencies met in practice which cause silk or cotton insulation to deteriorate rapidly and lose their value as insulating mediums. One of the principal advantages of enameled insulation, as compared with silk or cotton, is that it is very much less affected by heat than either cotton or silk, and will, in fact, carry a current and withstand heat for a long time which would cause silk or cotton to char. The enamel will withstand a temperature as high as 500° F. for a considerable length of time without injury to its insulating qualities. A number of interesting breakdown tests have been made and are set forth in a pamphlet which the Western Electric Co. will send upon request to all who are interested in the smaller sizes of insulated wire.

NEWS SUPPLEMENT

The Engineering Magazine—October, 1907

Personal.

—Carl R. Green, consulting mechanical engineer of Dayton, O., has completed the design of a line of pneumatic hammers for the Columbus Pneumatic Tool Co., Columbus, O.

—Mrs. Frances A. W. McIntosh has resigned the post of advertising manager of the Norton Company, Worcester, Mass., and has arranged to care for several Philadelphia accounts.

—F. B. Maltby, who has been connected with the Panama Canal work as principal assistant engineer to J. F. Stevens, has resigned to go with Dodge & Day, engineers and constructors of Philadelphia, in the capacity of chief engineer.

Industrial Notes.

—A recent municipal structure in which Raymond concrete piles were used in the foundation work is Public Bath No. 1, at 4th Avenue and President Street, Brooklyn, N. Y. The architect is Raymond F. Almirall.

—Parker Boiler Co., Philadelphia, are now erecting the fourth order received from the J. B. Stetson Co. of that city. When this order, which calls for two boilers of 750 H.P. each, is completed, the Parker boilers in the Stetson plant will aggregate 7,000 H.P.

—An order has been placed through Messrs. Westinghouse, Church, Kerr & Co., New York, with the Bradley Pulverizer Co. for Griffin mills for the equipment of the entire grinding plant of the 3,000 barrels per day Portland Cement Works now being erected by the Ajax Portland Cement Co., Independence, Kansas.

—Wm. B. Scaife & Sons Co., Pittsburg, have been awarded the contract for furnishing the structural steel work and steel storage bins for the new plant of the Henry Cowell Lime & Cement Co., Concord, California. Eleven buildings will be required, involving about 2,500 tons of structural steel.

—Among orders for foreign shipments recently received by the Buffalo Forge Co., Buffalo, is one covering a horizontal center crank compound automatic engine, 13 x 20 x 14, for direct connection to a General Electric Company's generator, this unit to be used for the electric illumination of the tower of Hoshiro which is located on the northwest coast of Japan.

—J. H. Wagenhorst & Co., Youngstown, manufacturers of electric blue printing machines, report among recent sales the following: E. R. Thomas Detroit Co., Detroit; J. Flood Walker, San Antonio, Tex.; Luzerne Engineering Co., Hazelton, Pa.; Surveyor General's Office, Cheyenne, Wyoming; J. E. Myers, Penn Station, Pa.; Harris Automatic Press Co., Niles, O.; American Thread Co., Holyoke; Phoenix Mfg. Co., Eau Claire, Wis.

—D. C. Newman Collins, consulting engineer and architect of New York, has recently issued a bulletin which will be found of considerable interest and benefit to parties contemplating the erection of a manufacturing plant, warehouse, mill, or in fact, anything in the way of an industrial building. It is a treatise going into detail on various kinds of structures, and the classes of materials and methods employed in erection.

—The new Hunt Street factory of The D. T. Williams Valve Co., Cincinnati, was visited by fire on August 22nd and the same was completely destroyed. They had just moved their lubricating department into this building prior to the fire and it is the only department to suffer—to the extent of tools and machinery; their patterns remaining intact at their Broadway plant. They have installed a temporary lubricating department at 410 East Eighth St., until their old factory is rebuilt, and they announce the delivery of lubricating devices about October 15th.

—The formal opening of the new reinforced concrete buildings which Keuffel & Esser Co., the well known manufacturers and importers of engineering and mathematical instruments, have erected at their plant in Hoboken, N. J., took place on July 20. The completion of the new buildings has practically doubled the company's facilities. The former general offices of the Company at 127 Fulton St., New York, had become too small and it was deemed advisable to remove them to the more commodious quarters provided in the new buildings in Hoboken. The building at 127 Fulton St., New York, is retained as the New York sales department and show rooms. The new buildings are located at the corner of Adams and Third Streets, Hoboken, N. J., directly across the street from the older portion of the plant. They are of reinforced concrete, and represent the latest progress in factory design and construction. The buildings are two in number, connected by a two-story structure. One contains the general offices, while the other is devoted entirely to manufacturing. They are practically the same in construction and together cover 30,000 square feet of ground. The Turner Construction Co. have erected both buildings.

NEW CATALOGUES AND TRADE PUBLICATIONS

NOTE—The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page 11.

Air Compressors.

CHICAGO PNEUMATIC TOOL CO., Fisher Bldg., Chicago.—Catalogue No. 23 is devoted exclusively to Franklin air compressors. It contains descriptive matter and information relating to air compressors and is illustrated with half-tone engravings of the machines and parts. Catalogue No. 24 illustrates and describes pneumatic tools and appliances, including hammers, drills, hoists, etc.

Blow-Off Valves.

LUNKENHEIMER CO., Cincinnaai.—Booklet containing an illustrated description of various types of blow-off valves, together with tables giving dimensions. 3½ by 6 in.; pp. 24.

Crane Controllers.

CUTLER-HAMMER MFG. CO., Milwaukee.—Booklet containing illustrations and descriptions of five types of electric crane and hoist controllers. Also contains connection and dimension diagrams, repair part charts, prices, etc. An improved form of contractor for handling heavy currents is also described. 3¾ by 8 in.; pp. 24.

Expanded Metal.

EXPANDED METAL ENGINEERING CO., 231 Fifth Ave., New York.—Catalogue illustrating and describing the expanded metal system of steel concrete construction, together with views showing structures on which this system has been employed. 9 by 5 in.; pp. 176.

Feed Water Purifiers.

F. E. KEYES & SON, 22 Broad St., New York.—Leaflet containing a brief illustrated description of feed water purifiers, together with prices and list of some of the users. 3¾ by 8 in.; pp. 4.

Forcing Presses.

WATSON-STILLMAN CO., 26 Cortlandt St., New York.—Catalogue No. 70 illustrates and describes hydraulic forcing presses. 6 by 9 in.; pp. 130. Catalogue No. 71 treats of hydraulic pumps and accessories. Illustrated. 6 by 9 in.; pp. 140.

Forges.

BUFFALO FORGE CO., Buffalo.—General catalogue No. 177, pocket size, illustrates and briefly describes forges, blowers, blacksmith tools, pumps, exhausters, ventilators, steam engines, air washers and humidifiers. They also issue separate catalogues on every subject listed in this general catalogue, going very much into detail concerning same. 3¾ by 6¾ in.; pp. 246.

Injectors.

HAYDEN & DERBY MFG. CO., 85 Liberty St., New York.—Catalogue devoted to an illustrated description of injectors, ejectors and jet apparatus. Strainers, drip funnels and swing check valves are also given a place. 6 by 9 in.; pp. 52.

Insulator Supports.

ELECTRIC CONTROLLER & SUPPLY CO., Cleveland.—Booklet illustrating and describing universal insulator supports for use where wire is to be supported from iron or steel fabrications. Made in four sizes, 3½ by 6 in.; pp. 16.

Locomotives.

BALDWIN LOCOMOTIVE WORKS, Philadelphia.—Catalogue No. 63, giving the dimensions of a number of recent locomotives recently constructed, together with illustrations of the same. 9 by 6 in.; pp. 32.

AMERICAN LOCOMOTIVE CO., 111 Broadway, New York.—Catalogue illustrating and describing the Prairie type locomotives built for various roads. Also contains the principal dimensions in tabulated form of fifteen different designs of locomotives of this type, ranging in weights from 136,000 to 245,000 pounds. 9 by 6 in.; pp. 40.

Oil Engines.

DE LA VERGNE MACHINE CO., Foot of E. 138th St., New York.—Folder illustrating and describing two cycle vertical engines especially designed for the use of cheap oils, kerosene or fuel oil, not for gas or gasoline. 4 by 9 in.; pp. 8.

Oilless Bearings.

ARCTO OILLESS BEARINGC O., Wayne Junction, Philadelphia. — Well-printed booklet illustrating and describing these bearings. They are made of wood that has been chemically treated, and require no oil or other lubricant. Also contains tables giving dimensions, prices, etc. 4½ by 7 in.; pp. 40.

Portable Tools.

H. B. UNDERWOOD & Co., 1027 Hamilton St., Philadelphia. — Catalogue giving an illustrated description of portable tools for railway repair shops. 6 by 9 in.; pp. 64.

Pumping Machinery.

GOULDS MFG. CO., Seneca Falls, N. Y.—Booklet illustrating and describing a large number of applications in which their power pumps are used. 4½ by 4½ in.; pp. 48.

LAWRENCE MACHINE CO., Lawrence, Mass.—Catalogue containing illustrations, descriptions and price lists of centrifugal pumping machinery and vertical steam engines. 9 by 6 in.; pp. 48.

Screens.

JEFFREY MFG. CO., Columbus.—Catalogue 69A illustrates and briefly describes many different types of screens. 6 by 9 in.; pp, 56.

Storage Batteries.

WESTINGHOUSE MACHINE CO., E. Pittsburg.—Catalogue 5-2 illustrates and describes storage batteries for stationary use. 6 by 9 in.; pp. 40.

Superheaters.

POWER SPECIALTY CO., 111 Broadway, New York.—Well-printed catalogue devoted to an illustrated description of Foster superheaters. Also contains views showing some recent installations, together with tables giving the carrying capacity of extra heavy steam pipes and of the properties of saturated steam. 6 by 9 in.; pp. 44.

Tanks and Towers.

W. E. CALDWELL CO., INC., Louisville, Ky.—Catalogue illustrating and describing tanks, towers and tubs, together with prices. 6 by 9 in.; pp. 36.

Tinsmiths' Tools and Machines.

NIAGARA MACHINE AND TOOL WORKS, Buffalo.—Catalogue, pocket size, illustrating and describing tinsmiths' tools and machines, shears, punches, rolls, presses, etc., together with sizes and prices. 4 by 6 in.; pp. 114.

Vanadium.

AMERICAN VANADIUM CO., Frick Bldg., Pittsburg.—Pamphlet describing the services of vanadium in steel making. It tells what it is, where it comes from, its useful strength in steel, what is wanted and how vanadium meets the demand. Also a pamphlet entitled "Vanadium. Its Services in Railroad Practice," by J. Kent Smith, being the report of an address and discussion before the Central Railway Club at Buffalo, March 8, 1907.

Water Purifying Apparatus.

WM. B. SCAIFE & SONS CO., Pittsburg.—Well-printed catalogue containing an illustrated treatise on the purification of water by the Scaife and We-Fu-Go systems. Also contains views of many recent installations. 8 by 10 in.; pp. 96.

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KNOWING THE VALUE of a self-filling pen and realizing the objections found in others, we have perfected the Welty New Idea. It has no doubtful parts, only strong points. We are offering it at prices that surprise our customers. Send to-day for further particulars. WILLIAM A. WELTY CO., Waterloo, Iowa. 3-11

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SLAUGHTER SALE: Bargains never equaled; high grade standard typewriters, rebuilt $15 to $40; sent allowing trial; send immediately for Bargain list.; excellent rentals $3. CONSOLIDATED TYPEWRITER EX., 243 Broadway, N. Y. (Established 1881.) Reliable. 1-10

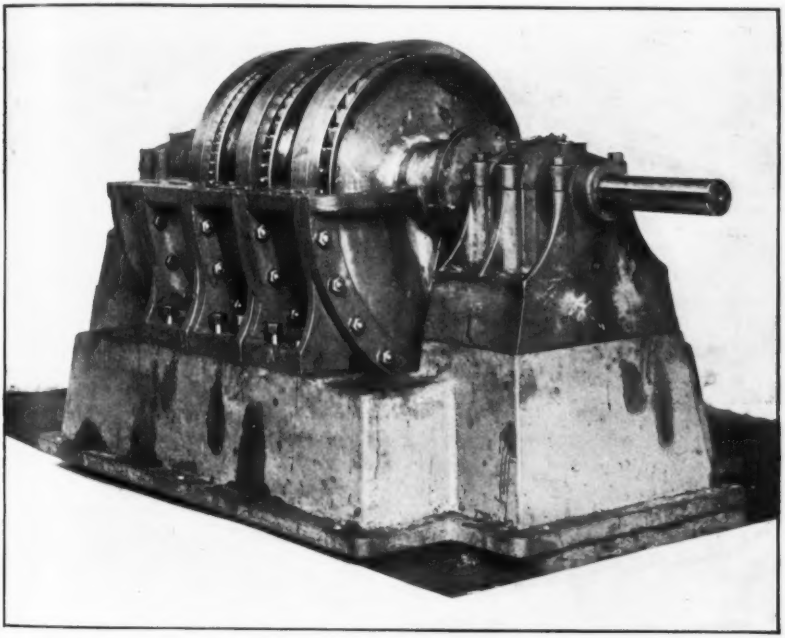
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Sturtevant Turbine.

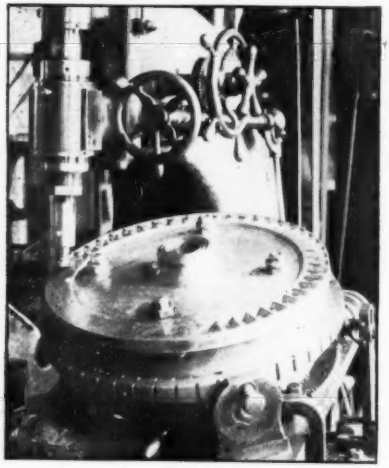
IN 1889, soon after the modern practical form of steam turbine appeared, the B. F. Sturtevant Company began experimenting along this line. The subsequent work was especially directed toward the production of a turbine suited to the peculiar requirements of driving blowers and small electric generators. This experimental work was conducted by William E. Snow of the engineering staff, and the turbine is built under his patents. Now fully developed and beyond the experimental stage, the Sturtevant turbine bids fair to supersede the reciprocating engine in many classes of work. It is especially successful in driving gas blowers.



Broadly speaking, steam turbines may be divided into two general types—the reaction and the impulse. Hero's machine was a reaction turbine, for the rotary motion was obtained from the reaction of the steam escaping from the bent tubes projecting from the rotating globe. A turbine in which a jet of steam is allowed to escape from a nozzle or tube at high velocity and in striking against blades on the periphery of a wheel cause the wheel to revolve in an impulse turbine. The well-known Pelton water wheel will serve as an example. Although turbines are so classified, they actually operate by both impulse and reaction and the real difference lies in the method of expanding the steam. If the steam is expanded in both the moving and the stationary parts, the pressure is not equal on both sides of the moving wheel and the machine is a reaction turbine; if,

however, the steam is expanded wholly in the stationary parts or nozzles, the pressure is practically the same on either side of the wheel and the result is an impulse turbine. The Sturtevant turbine belongs to this class.

A turbine having but one bucket wheel is usually termed a single-stage machine since the steam acts but once. The small and medium sizes of the Sturtevant turbines have but one wheel and therefore are called single-stage turbines but they are not single-stage machines in the usually accepted meaning of the word, for the



steam, after first acting on the buckets, is returned again and again to the same wheel until all the available energy is abstracted. This not only makes the wheel work with a very high efficiency, but also permits the use of moderate speeds of rotation as compared with other types.

The term involute is also applied to this make of turbine because of the working path of the steam. Sturtevant single-stage involute turbines are made in sizes ranging from 10 to 200 horse power, and are furnished in three sizes as regards their outside dimensions, the horse powers and speeds varying according to the arrangement of the nozzle and buckets. Turbines of a larger size than 200 horse power have from two to four bucket wheels, according to the speed and other working conditions.

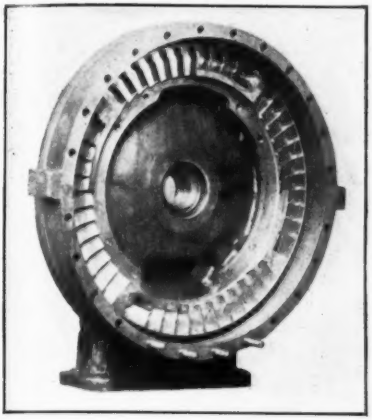
In the Sturtevant single-stage involute type of turbine two forms of wheel are used, one having the buckets cut in a single row on the rim, the other having two rows of buckets, one on each side. The former is an axial flow type of turbine, the latter a radial. The single-row type is used for all ordinary work, the double-row being reserved for cases where an unusually large amount of power is required in a small space. The single stage involute turbine is composed of but seven principal parts—the bucket wheel, the shaft, the reversing guide, rings, the casing, the bearings, the base and the governor. The only parts subjected to actual wearing contact are the two main bearings, and as the load upon these never exceeds 14 pounds square inch of bearing surface, they last indefinitely. The deep base, which the extremely small diameter of this turbine necessitates, is utilized for carrying the steam and the exhaust, which are connected directly to the base, thereby doing away with all unsightly overhead piping. The steam passages in the base are also arranged to form a separator, which always insures dry steam so essential to long life of the nozzle.

Due to the methods of returning the steam again and again into the bucket wheel until all the available kinetic energy is abstracted, the speed of this turbine is comparatively low, ranging from 1,600 to 3,000 revolutions per minute. This permits of direct connection to blowers and high-speed machinery and avoids the use of gears and other reducing devices.

The bucket wheel is a single forging of the best grade of open hearth steel, with the buckets worked out of the solid metal. This process insures a wheel of great strength, and also does away with all possibility of the breaking of the blades of the buckets, as sometimes occurs with wheels of the inserted blade type. If the bucket wheel of the Sturtevant turbine should get out of line and touch the casing the result would be merely a rubbing together of two steel plates and could not produce the slightest injury to the buckets. The steam is admitted to the buckets in such manner that the wheel is always in perfect balance and end thrust is eliminated. The buckets are cut with a special form of milling cutter on an automatic machine which ensures great accuracy and a perfect finish to the steam surfaces.

Every part of the turbine is designed for the utmost simplicity consistent with economy of operation, and no delicate adjustment of the rotating and stationary parts is required, for the bucket wheel has a running clearance of 1/16 of an inch all round.

The bearings are of the self-aligning type, ring-oiling, with solid linings of phosphor

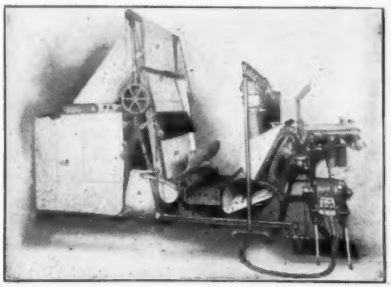


bronze. The reversing guide rings are of forged steel, having buckets similar to those in the wheel milled into them; at intervals, between the buckets the steam nozzles are inserted. The nozzles are made from the best Tobin bronze, shaped with the special reamers that give the greatest accuracy and smoothness of finish. They are inserted in the reversing guide rings, and are easily removable at any time for renewal. There are no stuffing boxes used on the shaft, steam tightness being secured with a short labyrinth or water packing. There is no contract between the rotating and the stationary parts of this packing, therefore it requires no adjustment and will wear indefinitely without leakage. The governor is direct-connected, thereby doing away with all gears, belts, and speed-reducing devices. It is composed of but four parts, and one spring, and is located on the end of the outboard bearing and enclosed in a dust-proof case. The regulating valve, consisting of but three parts, is of the throttling type and located beneath the governor, on the steam inlet. It is simple and positive in action. The extreme simplicity and strength of the Sturtevant turbine make it more comparable to a blower than an engine as regards attendance and cost of upkeep, the only attention it requires when in continuous operation being a weekly filling of the oil wells in the two main bearings. Other than this it requires no attention whatever, as the whole machine is enclosed in a dust-proof case affording it absolute protection from injury and making it practically "fool-proof."

Blue Printer and Washer.

THE accompanying illustration shows an electrical blue-printing machine that will print, wash, and dry in one continuous operation. There are various types of electrical blue-printing machines manufactured in the United States, England and Germany that will make blue-prints by electric light, but it is claimed that the Franklin electric continuous blue-print machine is the only one that does the work in one continuous operation. The advantage of this is quite evident, as it does away with the long lines on which to hang the prints after having been exposed to the electric light and printed, and does away with all trays for washing the prints, thus avoiding wet floors caused by the dripping of the water from the prints when drying.

A machine of the capacity shown in the illustration will turn out from five to eight thousand square feet of blue-prints a day.



Another advantage in having the washing and drying done by mechanical process is that the prints are potashed by a forced spray and then washed in running water. This gives a deep blue to the background and a clear white line, and produces a very much finer quality of print than those made by electric light or sunlight, unless they

are passed through a solution of potash, which, of course, takes considerable time when done by hand. The machine will print either continuously or make single prints, and is so arranged that three or four prints may be made at any time during the day when a larger number is not wanted. The drying is accomplished by means of steam, electricity or gas. Owing to the method of drying the prints come out perfectly flat without any distortion. The surface of the paper being washed on one side only, the top of the blue-print is not saturated so thoroughly with the water, and hence the scale is not distorted.

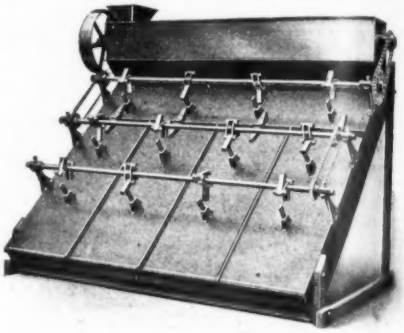
The machine, however, may be bought separately from the washing and drying apparatus if desired, while the washing and drying machine can be attached to any horizontal make of continuous electrical blue-printer.

Williams, Brown & Earle, Philadelphia, Pa., have recently issued a catalogue of blue-printing machines which gives other illustrations and a fuller description of this combined blue printer with washing and drying machine.

A New Principle in Screening.

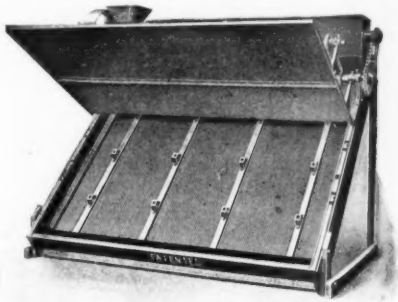
MORE than 2,000 years B. C. the Egyptians made a screen of interwoven reeds, enclosed in a frame, filled the frame with material to be screened, and then began to shake. For four thousand years we have blindly followed their idea, and although we have improved on the screen itself, we have continued to shake. For we have wasted energy and money in shaking our screen frames and their attendant mechanisms to pieces, to say nothing of the wear and tear on the screen itself; and all this with very indifferent success as regards the screened product.

It was for W. J. Bell, of the Newaygo Portland Cement Co., Newaygo, Michigan, to suggest the alternative in this case. The frame to his separator is rigid; the screen frame is not shaken, but the screen cloth itself is vibrated like a piano wire. This seems to solve the vexed question of economical screening. This separator, styled the "Newaygo" separator, is an inclined, vibrating screen, framed in steel and enclosed in steel. The screen cloth is automatically kept in strong, uniform tension, and is vibrated by small hammers constantly tapping its protected surface. This remarkably simple and ingenious device for producing vibrations secures astonishingly rapid and sharp movements, yet of small amplitude. These indestructive vibrations give material in process of screening the



least possible projection, and offer it innumerable opportunities to pass through the clean screen openings before tailings escape at the foot.

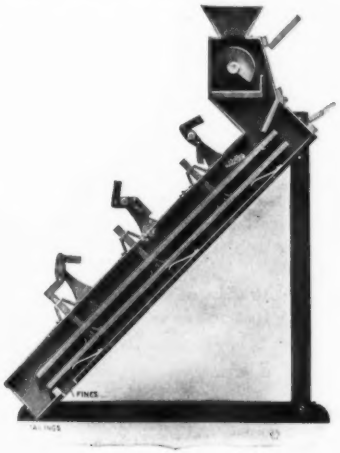
Owing to the rapid and continuous small, but highly effective screen-cleaning vibrations of the screen cloth, the material, if sufficiently dry, never clogs. These



small cleansing shocks cannot become deadened because the screen automatically maintains its required tension.

An inclined, vibrating screen must necessarily have a much larger capacity than others, because it cannot so easily clog, because all its surface works all the time, and it is no small advantage that coarser wire and meshes can be used to produce

the same output than are possible in the old constructions. Large wires are clearly more durable than small ones. In an inclined vibrating screen, coarse wire can be successfully used for very fine work, because inclining the screen surface diminishes the size of the openings, and the little, sharp vibrations keep the pores open. Material in process of screening will not race down an inclined, vibrating wire surface, nor will it leap far, and thus skip many opportunities of escape; nor will it bound on the wire with cutting force, but partakes of a steady flow with millions of little screen-cleaning shocks that open the pores and constantly invite the escape of the finest materials long before they have reached the foot of the screen.



The fineness of output can be controlled to a considerable extent by changing the inclination of the screening surface (this change being made by moving the adjustable supporting legs), which has the same effect as diminishing the screen mesh. The opportunities for material to pass through the clean meshes of a vibrating screen are so infinitely more numerous than in the old "shaker," or round screens, that the tailings, even in rapid work, and with small meshes, must be much cleaner than usual. The screen, or screens (one or two screens of any mesh up to 100 may be used) can be readily withdrawn for replacement or cleaning.

The output that may be obtained from "Newaygo" separators is from ½ inch up to 299 mesh, with capacities varying from 40,000 lbs., according to the material and fineness of screen cloth. Mr. Bell has seventeen of these inclined, vibratory separators in constant use at the Newaygo Portland Cement Works, and believes that the problem of simple, economical screening has been solved. The Sturtevant Mill Company, 109 Clayton St., Boston, Mass., has underwritten this separator, and hereafter it will be sold exclusively by them.

Oilless Bearings.

ARGUTO oilless bearings are made of wood that has been chemically treated and are particularly advantageous where absolute cleanliness is of importance. No graphite or other uncleanly material is used in the manufacture of Arguto. The bearings require no oil or other lubricant, although should oil for any reason get on the bearings, no harm will result. These bearings have been applied with particular success to loose pulleys, friction clutches, light shafting, countershafts, etc.

The Arguto Oilless Bearing Co., Wayne Junction, Philadelphia, have issued a catalogue showing many interesting applications of the oilless bearing and they will furnish copies free to those making inquiry.

Kewanee Flange Union.

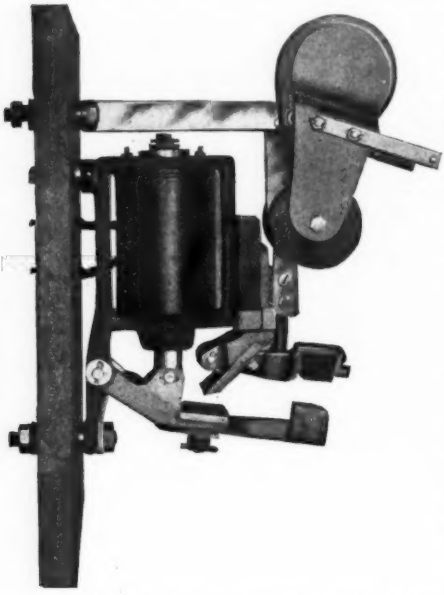
THE Kewanee flange union is made entirely of malleable iron, excepting the brass seat, which is made practically integral with the malleable part by the only method which experience has shown to be enduring. This construction gives a very compact fitting, light in weight, and at the same time one that combines extreme strength with rigidity. There is no danger of breaking these malleable flanges in pulling the joints together, while cast-iron flanges, on the contrary, are frequently broken in the process of coupling. In this flange union the convex surface of malleable iron comes in contact with the concave surface of brass. This junction of hard and soft metal insures a more perfect seat than could be obtained otherwise, it making no difference whether the pipe is in alignment or not.

Each fitting is given a severe air pressure test under water before sent out.

It is manufactured by the Western Tube Co., Kewanee, Ill., who will furnish full details upon request.

Improved Contactor.

THE Cutler-Hammer Mfg. Co., of Milwaukee, makers of electric controlling devices, have recently placed on the market an improved style of contactor. These contactors are used for handling main line currents where the nature of the service is severe. In such cases controlling employing sliding contacts cannot be relied upon to handle the main line current, and it is customary to employ a controlling panel consisting of a number of contractors, this panel in turn being con-



trolled by a master controller designed to regulate the secondary current which energizes the solenoids of the contactors. The improved contactor here illustrated is a compact and strongly constructed piece of apparatus, and is provided with an exceptionally powerful blow-out magnet. The main line circuit is closed by the solenoid raising a pivoted arm carrying a thick copper plate, to a point where contact is made with a pair of stationary, laminated copper brushes. Arcing on this contact is prevented by providing an auxiliary copper and carbon contact in the field of a powerful blow-out magnet, which instantly extinguishes the arc incident to the breaking of the circuit. This auxiliary contact closes before the main contact is made, and opens after the main contact is broken, thus effectually preventing any sparking on the main contact.

A noteworthy improvement is the pivoting of the blow-out shields, permitting these to be raised (as shown in illustration) so as to expose the auxiliary carbon and copper contact. In earlier types of contactors these shields were rigidly fastened in their normal position, completely covering the copper and carbon contacts, and rendering access to them difficult.

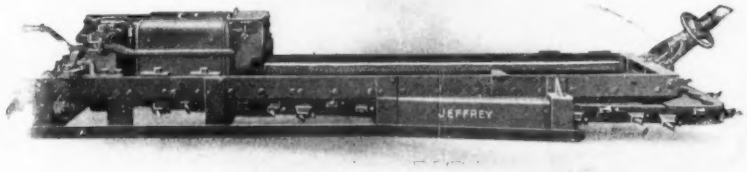
The present construction makes renewal of either contact, or of the coiled spring (visible just above the carbon contact) a matter of a few moments only. At a recent test at one of the largest Pittsburg steel mills a 200 volt circuit was opened and closed by a contactor of this type 88,000 times, before removal of the copper and carbon contacts became necessary, and —on a test to determine time required for repairs—the old contacts were removed and new ones inserted in less than two minutes.

Jeffrey Mining Machines.

THE Jeffrey mining machines with flame tight motors and starters shown in the accompanying illustrations were brought out almost simultaneously with the publication of the British Departmental Committee's report upon the use of electricity in mines. This report, which embodies rules for the use of electricity in mines, recommended the adoption of entirely enclosed motors and auxiliary devices, such as starters, terminals, etc., for all mines coming under general rule No. 8 of the Coal Mines Regulation Act of 1887.

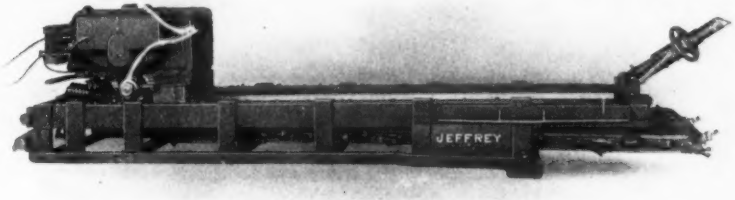
Mining machine motors of necessity have to be designed to be very compact. It is therefore necessary that every advantage be taken of space, so that the motors will not heat excessively under their regular duty. In this country where our mines are

very free from gas, the open type of motor has found favor on account of its accessibility, and on account of the fact that the same motor capacity can be put into smaller space in the open type than in the enclosed type. By careful designing, however, the Jeffrey Manufacturing Company have been



able to put upon their mining machines motors of the enclosed type which are of equal capacity to those of the open type formerly used, and the enclosed motors occupy practically no more space than those of the open type.

The Jeffrey 21-A mining machine motor, which is typical of other enclosed mining machine motors made by this company, is a modern motor in every respect. The armature is drum wound with machine formed coils. The pole pieces are of laminated sheet steel, and the windings of both



the armature and field coils are insulated in the most approved manner for mining machine service. This service, by the way, is probably the most severe of any service which electric motors are called upon to perform. The insulation has to withstand both oil and moisture, as well as heat, and infinitely more dirt and less attention than in any other service known. The motors illustrated are provided with self-oiling ring oiling bearings, which are so arranged that the oil hermetically seals the motor so that any gas which may accumulate about the motor cannot possibly be ignited by sparking at the brushes, or any interior trouble with the motors. Over the commutator of this motor is a plate glass door protected by a heavy malleable iron lid. Through the plate glass door, the brushes may be observed without opening the motor to mine gases. The starting switch for this motor is protected in a similar manner to the motor itself, all contacts being hermetically sealed in flame-tight metal casings. The inspector for the British Government who recently inspected these motors pronounced them as conforming in every particular to the rules and requirements of the Departmental Committee.

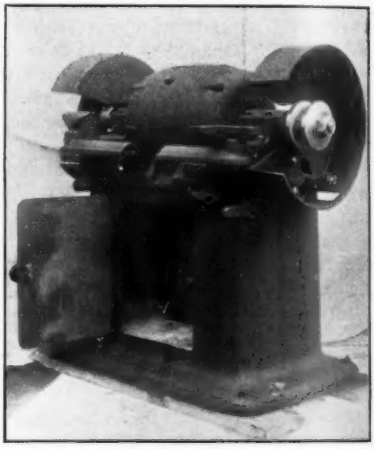
An advantage of these motors is that they can be applied directly to Jeffrey mining machines with no other change than the removal of the existing open type motors. They are wound for standard voltage of 220, 250 and 500 volts, and may be wound special for other voltages where

requirements demand it. Attempts have been made by the manufacturers of coal cutting machines to develop an enclosed type motor, which motor would not only conform to the rules and requirements of the English Government, but would at the same time be an efficient motor and one so designed as to reduce to the lowest possible point the expense of keep up; but up to this time no such motor has been put upon the market by any builder save the Jeffrey Mfg. Co. This company has not only brought out the 21-A motor for what is commonly designated as the standard type of chain breast machine, but they have also brought out the 27-A motor, which is a motor of the enclosed type conforming strictly to the mining laws, which is adaptable to low or thin vein machines. The demand for such machines equipped with both of these motors has been very extensive, and since the motors were put on the market machines equipped with same have been ordered by the largest coal companies, not only in Great Britain but in the English colonies where the rules of the Home Government are effective.

Ransom Speed Controller.

AS grinding wheels wear down it is necessary to speed up the arbor in order to keep the wheels running at the right peripheral speed to do the greatest amount of work with the least wear to the wheel. This has been accomplished in various ways, such as the use of cone pulleys, variable speed motors, etc. These methods have been very unsatisfactory, however, as very few operators will take the time to figure out the proper speed that an emery wheel should run at. They merely increase the speed by guess, with the result that the wheels are run too slow to do their work properly, or so fast they are liable to break, thus endangering life and destroying the wheel.

With the Ransom speed controller there is no guess work, the operator knows that the grinding wheels are running at the proper speed to do the most work. A 75% speed variation is obtained by means of external field control, and constant peripheral speed is maintained until the wheel is practically worn out. The speed of the grinding wheel is regulated by a gauge or roller which is directly under the wheel and which is mounted on a transverse rocker shaft running the length of the machine. As the wheels wear down these rollers are set so that they touch or nearly touch the wheels. The adjustment of these rollers is accomplished by means of an arm, which is connected to the transverse rocker shaft and comes forward, as shown in the illustration, and is in easy reach of the operator. The adjustment of these rollers automatically moves the arm on a field rheostat in the base of the machine, thus cutting the resistance coils in



and out of the motor circuit, one after another, which in turn regulates the speed of the motor for that particular size grinding wheel. If one wheel wears down faster than the other the speed is regulated by the larger of the two, as it is impossible to move the roller on one end only, thus preventing the machine being run too fast for the larger wheel.

The Ransom speed controller can be attached to any of the Ransom motor driven grinders for direct current and is manufactured by The Ransom Mfg. Co., Oshkosh, Wis.

News Supplement

The Engineering Magazine—November, 1907

Personal.

—Walter B. Snow, 170 Summer Street, Boston, announces that he is prepared to undertake work of any kind in the broad field of publicity for manufacturers of machinery and allied products. His regular service will cover the conduct of the publicity departments of a limited number of non-competitive clients. Special service will be rendered to others in the form of general advertising, catalogue making, technical writing and investigation. Mr. Snow for nearly 25 years was connected with the B. F. Sturtevant Co.

Industrial Notes.

—The Ridgway (Pa.) Dynamo & Engine Co. has re-opened its Chicago sales office at 824 Marquette Building. F. S. Hickok is in charge as manager.

—The American Society of Mechanical Engineers will hold its next regular monthly meeting on Tuesday evening, November 12, at 8:15 o'clock, in the building of the Engineering Societies, 29 West 39th Street, New York.

—The General Fireproofing Co., Youngstown, has been awarded the contract for furnishing and erecting pin-connected girder frames and cold twisted lug bars as reinforcement for two new reinforced concrete buildings for the Victor Talking Machine Co., Camden, N. J.

—The Bucyrus Co. announces that conjointly with its Philadelphia agent, the Standard Supply and Equipment Co., it has established an office in New York City in the Singer Building, Broadway and Liberty street, under the management of James M. Reed.

—The Hunt Engineering Co. have placed an order with the Lehigh Car, Wheel & Axle Works, Catasauqua, Pa., for the necessary pulverizing machinery for the 2,000 barrel plant (shale and limestone) being built at Chanute, Kansas, for the Ash Grove Lime & Portland Cement Co.

—Some months ago Cutler-Hammer Mfg. Co., Milwaukee, announced the purchase of The Wirt Electric Co., Philadelphia. They now state that they have consolidated the Wirt business with that of their New York plant at Park Ave. and 130th St., where the manufacture of Wirt apparatus will be continued.

—Dodge & Day, engineers and contractors, Philadelphia, have submitted a betterment report covering the entire factory of Fayette R. Plumb, Inc., Frankford, Pa., and are now engaged in making extensive alterations to the forge shops. When this work is finished other departments will be taken up and ultimately the entire plant will be remodeled.

—The Ridgway Dynamo & Engine Co., Ridgway, Pa., are distributing a set of templets showing the floor space occupied by their standard generating units in sizes from 10 K.W. to 200 K.W. inclusive. These templets are made to a scale of ¼" to the foot and should be of great value to consulting engineers, architects and others who have occasion to lay out power plants.

—Frank Nebeling has recently arrived from Europe with models of a new automatic car coupler which is now being tried out on the German State railways and received a gold medal at the Milan exposition. Mr. Nebeling, whose address is 2002 Webster Avenue, New York, desires to place the rights of manufacture for the United States.

—The Westinghouse Electric & Manufacturing Co., East Pittsburg, has received through G. & O. Braniff & Co., agents for the former company in Mexico, an order for one of the electrical equipments of the Vera Cruz tramways, built by the Vera Cruz Light, Power & Tramway Co. Vera Cruz is the second city in Mexico to be electrified.

—McKesson & Robbins, New York, have commissioned Dodge & Day, engineers and constructors of Philadelphia, to make the

additions to their present power plant. The addition will include a new engine, generator and necessary changes to piping, wiring, etc. Messrs. Dodge & Day made a report on power requirements for this concern some time ago and the present work is the result of that report.

—The Standard Roller Bearing Co., Philadelphia, has increased its capital of $3,500,000 to $5,000,000. Large additions are now being made to the plant and equipment for the purpose of enlarging their department for the manufacture of roller bearings for shafting hangers and also for the establishment of an entirely new department for the manufacture of roller bearings for trolley cars.

—It has been officially confirmed that the Seaboard Portland Cement Co., which plant is to be built at Alsen, New York, have placed an order with the Lehigh Car, Wheel & Axle Works, Catasauqua, Pa., covering their entire pulverizing requirements, comprising forty-five 42-inch Fuller-Lehigh pulverizer mills, capable of pulverizing the coal, raw material and clinker for their 6,000 barrel plant.

—Among recent sales of electric generating sets the B. F. Sturtevant Co., Boston, report the following: Electric Construction Co., Richmond, Va.; McCann Ice Plant, Philadelphia; Bethlehem Brewing Co., New Bethlehem, Pa.; Smith & Hammond Lumber Steamers; Eberhard Faber Pencil Co., Brooklyn; Metric Metal Works, Erie; Hanover National Bank Bldg., New York; Sedalia Ice, Lt. & Fuel Co., Sedalia, Mo.; H. J. Kunzig, Philadelphia; and Board of Water Supply, New York.

—The Power Specialty Co., New York, has recently concluded arrangements whereby it has secured the exclusive sale of Duval Metallic Packing in this country, Canada and Mexico. It will carry a complete stock of this packing in standard sizes, enabling it to fill orders promptly. This company has just received from the press a new and enlarged catalogue descriptive of the Foster Superheater and other steam specialties including the packing mentioned, copies of which will be forwarded upon request.

—In times like the present when most foundries are running to full capacity, the managers naturally dread the extreme heat because, if it is not impossible for the men to work, it is, at least, distasteful to them and much time is lost. When it is considered that this condition in a foundry can easily be overcome and at no great cost, it is strange that more foundries do not adopt the most modern system of heating and ventilating which makes it possible to cool and ventilate in the summer time and enables the foundry to run continuously. The American Blower Company, Detroit, have paid especial attention to this branch of their business and have done some excellent work.

—The American Steel & Wire Co., after having in operation a 12,500 H.P. We-Fu-Go water softening and purifying system for six months at their Donora Works, have just placed an order with Wm. B. Scaife & Sons Co., Pittsburgh, for a 25,000 H.P. We-Fu-Go system, consisting of eight large treating and settling tanks and eight mechanical gravity filters, for their Newburgh Steel Works, Cleveland. Other sales reported by them are: Rochester & Pittsburgh Coal & Iron Co., Punxsutawney, Pa., 2,250 H.P. We-Fu-Go system; Shenango Furnace Co., Sharpsville, Pa., 8,000 H.P. We-Fu-Go system; Armstrong Cork Co., Oakdale, Pa., 500 H.P. We-Fu-Go system; Fostoria Glass Co., Moundsville, W. Va., 350 H.P. We-Fu-Go system; The Allen & Wheeler Co., Troy, O., 200 H.P. We-Fu-Go system; Stone & Webster Engineering Corporation, Boston, 2,500 H.P. We-Fu-Go system for Jacksonville Electric Co., Jacksonville; The Paterson Parchment Paper Co., Passaic, 150,000 gallon per hour We-Fu-Go continuous system.

—Recent sales by L. J. Wing Mfg. Co., of New York, of turbine blowers for mechanical draft and disc fans, ventilation, etc.: N. Y. Telephone Co., New York; Brooklyn Union Gas Co., Brooklyn; Siegel Cooper Co., New York; Hahne & Co., Newark; Cumberland Glass Co., Bridgeton, N. J.; Arnold Print Works, No. Adams, Mass.; Sayles Bleacheries, Saylesville, R. I.; Diamond Paper Mills, Saugerties, N. Y.; Henry Heide, New York; A. M. Powell, New York; Irving National Exchange Bank, New York; Bernheimer & Schwartz Brewing Co., New York; Henry Elias

Brewing Co., New York; Columbus Forge & Iron Co., Columbus; Modern Steam Laundry, New York; Hudson Laundry, Jersey City; Terry & Tench, New York; Lidgerwood Mfg. Co., New York; Metropolitan Life Ins. Co., New York; Doerr, Mitchell & Co., Spokane, Wash.; Parker Stearns & Co., New York; J. S. Bailey & Co., New York; Geo. I. Roberts & Bro., New York; Rochester Electric Motor Co., Rochester; Egler's Bakery, New York; Panama R. R. Co., New York; B. Remmers & Son, Philadelphia; Forbes & Wallace, Springfield, Mass.; Thompson & Norris Co., Brooklyn.

—*General Electric Review*, published by the General Electric Co., Schenectady, for October contains the following articles: A Model Electric Bakery, by Chas. B. Davis; Centrifugal Compressors for Industrial Air Blast, by Dr. S. A. Moss; Power Requirements of Railroad Shop Tools, by L. R. Pomeroy; Electrical Equipment of a Large Brewery, by Wm. Hand; Fundamental Principles of Centrifugal Fans, Part II, by Maxwell W. Day; Magnetite Headlight, by G. N. Chamberlin; New Low Tension Magneto, by M. J. Fitch; Electric Drive in Cotton Gins, by A. N. Feinemann; Cost of Cooking by Electricity; Individual Motor Drive for Lithographic Presses, by R. J. Binford; Notes on Emergency Repairs, by W. G. Ely, and Abstracts of Important Technical Articles.

NEW CATALOGUES AND TRADE PUBLICATIONS

Note—The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page 11.

Air Compressors.

Philadelphia Air Brake Co., Philadelphia.—Catalogue describing motor driven air compressors. Illustrated. 10 by 6½ in.; pp. 24.

Ball Bearings.

Chapman Double Ball Bearing Co. of Canada, Ltd., Toronto.—Well-printed booklet entitled "The Factory Behind the Bearing," illustrating and describing the various kind of bearings manufactured by this Company. These bearings are especially adapted for use wherever friction exists. 6 by 9 in.; pp 24.

Ball Retainers.

Star Ball Retainer Co., Lancaster, Pa.—Pamphlet illustrating and describing anti-friction ball retainers, together with sizes and prices. 5½ by 3½ in.; pp. 16.

Blue Printing Machines.

Williams, Brown & Earle, 918 Chestnut St., Philadelphia.—Catalogue illustrating and describing the Franklin automatic continuous feed electric blue printing machines and blue print washers and dryers, together with prices. 6 by 9 in.; pp. 18.

Bookcases.

B. B. Lundstrom Mfg. Co., Little Falls, N. Y.—Catalogue containing an illustrated description, with prices, of sectional bookcases and filing cabinets. 8 by 10 in.; pp. 44.

Calipers.

J. T. Slocomb Co., Providence.—Catalogue illustrating and describing micrometer calipers, together with prices. 6 by 9 in.; pp. 32.

Concrete Steel Bridges.

Strauss Bascule & Concrete Bridge Co., Chicago.—Well-printed catalogue illustrating and describing bascule and concrete bridges as economical substitutes for swing bridges and fixed steel structures. 10 by 7 in.; pp. 80.

Cutting-Off Machines.

Nutter, Barnes & Co., Boston.—Pamphlets illustrating and describing metal saw cutting-off machines and automatic saw sharpeners. 6 by 9 in.; pp. 12.

Die Milling Machine.

Thurston Mfg. Co., Providence.—Catalogue containing an illustrated description of die milling machines. 8 by 9 in.; pp. 8.

Digging Machinery.

The Hayward Co., 97 Cedar street, New York.—Catalogue No. 30, a volume of 152 pages, 10 by 12 in., containing more than 300 finely executed half-tone views and pen drawings illustrating the various styles of Hayward orange-peel and clam-shell buckets, as well as many types of machines by which they may be operated. The views include plants suited to every variety of grading, coal-handling and ditch digging for railroads, dredging and deepening canals and harbors, excavating for canals and sewers, excavating inside of caissons for bridge piers, ore-bed digging, phosphate digging, placer mining and cellar digging, and the general handling of broken stone, clay, rock, sand, and coal. While the major portion of the catalogue is devoted to the machinery built by the Hayward Co., plants constructed by other firms are

also illustrated for the purpose of showing the application of Hayward buckets to any hoisting apparatus. The descriptions showing the application of these buckets to different classes of digging are notable for their clearness and the wide range of operations covered. The complete line of the machines manufactured by the Hayward Co. is not shown, for the reason that individual machines are necessary for certain kinds of work.

Drills.

KNECHT BROTHERS CO., Cincinnati. — Booklet illustrating and describing friction sensitive drills for drilling holes up to 9/16 of an inch. 3½ by 6 in.; pp. 16.

Dump Wagons.

TIFFIN WAGON CO., Tiffin, Ohio.—Catalogue No. 4 illustrating and describing dump wagons, together with specifications. 4 by 7 in.; pp. 16.

STUDEBAKER BROS. MFG. CO., South Bend, Ind. —Catalogue illustrating and describing dump wagons for all purposes. 8½ by 7½ in.; pp. 40.

Electric Motors.

B. F. STURTEVANT CO., Boston.—Bulletin Nos. 144 and 147 illustrate and describe electric motors of the eight-pole type and bi-polar and four-pole types respectively. They also contain tables giving dimensions. 6 by 9 in.; pp. 8.

Electrical Equipment.

FORT WAYNE ELECTRIC WORKS, Ft. Wayne, Ind.—Bulletins Nos. 1094, 1095, and 1096 illustrate and describe direct-current generators, multiple arc lamps and transformers respectively.

Feed Water Heating.

HARRISON SAFETY BOILER WORKS, 3138 No. 17th St., Philadelphia.—"Heating Boiler Feed Water Where the Main Engine is Run Condensing," is the title of a treatise showing that by using the exhaust steam of boiler feed pumps, circulating pumps and air pumps for preheating the boiler feed-water, the efficiency of these pumps becomes much higher than that of the best triple-expansion, condensing engine. At the same time, steam-driven machines of this character are much less expensive in first cost and the cost of attendance, are less liable to get out of order and may be operated when the main engine is standing idle, which, of course, is not the case with directly-connected or electrically-driven auxiliaries. The illustrations and text cover the engineering phases of the subject, including methods of operating barometric and surface condensers, the effect of air in the condensers of steam turbine plants, description of a typical street railway power plant, etc.

Fuel Economizers.

GREEN FUEL ECONOMIZER CO., Matteawan, N. Y.—Bulletin No. 113 contains a reprint of a paper read by R. D. Tomlinson before the New York Railway Club on the fuel economizers at the Manhattan Power Station of the Interborough Rapid Transit Co., New York. 6 by 9 in.; pp. 8.

Gasoline Engines.

FERRO MACHINE AND FOUNDRY CO., Cleveland. —Catalogue containing a treatise on marine gasoline engines. Well illustrated. 7 by 10 in.; pp. 64.

Gas Producers.

WILE POWER GAS CO., Rochester, N. Y.—Catalogue A, Section III, is devoted to an illustrated description of suction gas producers for cheap power. 6 by 9 in.; pp. 20.

Gears.

BOSTON GEAR WORKS, Boston.—Catalogue E is devoted to a brief illustrated description of chains, sprockets, bearings, steering devices, etc. Also gives dimensions, prices, etc. 3½ by 6 in.; pp. 90.

Grinding Machinery.

CLIZBE BROS. MFG. CO., Plymouth, Ind.—Catalogue devoted to an illustrated description, with prices, of grinding machinery. Countershafts and columns are also treated. 6 by 9 in.; pp. 56.

Grab-Bucket Cranes.

BROWN HOISTING MACHINERY CO., Cleveland. —Pamphlet illustrating and describing locomotive grab-bucket cranes for the handling of ore, coal, limestone, slag, sand, etc. Also contains a partial list of users. 6 by 9 in.; pp. 28.

Hoisting Engine.

CEMENT MACHINERY CO., Jackson, Mich.—Leaflet giving a brief illustrated description of a contractors' hoisting engine. 6 by 8½ in.; pp. 4.

Hoisting Machinery.

PARKER HOIST & MACHINE CO., Chicago.—Catalogue No. 19 treats of engines, derricks, cranes and hoists. Illustrated. 5 by 7 in.; pp. 90.

Hydraulic Machinery.

WATERBURY FARREL FOUNDRY & MACHINE CO., Waterbury, Conn.—Catalogue, section H, illustrating and describing valves, presses and draw benches, power pumps and accumulators. 6 by 9 in.; pp. 152.

Industrial Cars.

CHASE FOUNDRY & MFG. CO., Columbus, Ohio. —Catalogue No. 7 contains an illustrated description of industrial cars and trucks for all purposes. Also gives sizes, prices, etc. 5½ by 7½ in.; pp. 96.

Marine Cableway.

LIDGERWOOD MFG. CO., 96 Liberty St., New York.—Catalogue illustrating and describing marine cableways for the coaling of warships at sea. 8½ by 11 in.; pp. 48.

Power Plants.

RIDGWAY DYNAMO & ENGINE CO., Ridgway, Pa.—Bulletin No. 18 contains illustrations showing the interior of some of the power plants recently equipped by this Company with steam and electric power machinery. 8 by 10½ in.; pp. 18.

Prospecting Machinery.

Cyclone Drill Co., Orrville, Ohio.—Catalogue illustrating and describing prospecting machinery for coal, water, oil, gas, mineral and placer mining. 6 by 9 in.; pp. 84.

Pumping Machinery.

Edw. M. Prescott Steam Pump Co., Milwaukee.—Catalogue No. 20 illustrates and describes a number of different types of pumps and pumping engines, together with tables giving dimensions. The catalogue is well printed and illustrated. 6 by 9 in.; pp. 146.

Punching Machinery.

C. E. Sutton Co., Toledo.—Bulletin illustrating and describing single and double punches and shears. 6 by 9 in.; pp. 32.

Reinforced Concrete.

Trussed Concrete Steel Co., Detroit.—"Trussed Concrete Illustrated—Part 4" deals with reinforced concrete as applied to hotels, residences and apartment houses. Is illustrated with views showing many such buildings recently constructed by this company. 5¼ by 8 in.; pp. 21.

Screen Separators.

Sturtevant Mill Co., Boston.—Catalogue No. 77 illustrating and describing the Newaygo separator for separating all moderately dry, pulverized materials. 8 by 10½ in.; pp. 20.

Skylights.

E. Van Noorden Co., Boston.—Catalogue C illustrating and describing skylights, windows, ventilators and sheet metal work, together with views showing some recent installations. 9 by 6 in.; pp. 64.

Stamp Milling Machinery.

Colorado Iron Works Co., Denver.—Catalogue No. 6-C contains some illustrations and descriptions of machinery for use in the treatment of ores by stamp milling and amalgamation. 6 by 9 in.; pp. 72.

Steam Engines.

Minneapolis Steel & Machinery Co., Minneapolis.—Brochure No. 12 contains a brief illustrated description of standard heavy duty Corliss engines. 6 by 9 in.; pp. 32.

Steam Pumps.

M. T. Davidson, New York.—Catalogue containing an illustrated description of steam pumps and pumping engines. 6 by 9 in.; pp. 96.

Steam Traps.

Templeton Manufacturing Co., Boston.—Pamphlet illustrating and describing automatic steam traps. 14 by 11 in.; pp. 8.

Steel Plate Construction.

National Boiler & Sheet Iron Works, Indianapolis.—Catalogue partially describing and illustrating their plant and equipment, also showing views of some of the work recently constructed. 9 by 6 in.; pp. 42.

Steel Sheet Piling.

Carnegie Steel Co., Pittsburg.—Pamphlet illustrating and describing United States steel sheet piling and Friestedt interlocking channel bar piling. 5 by 7½ in.; pp. 16.

Turbine Pumps.

Watson-Stillman Co., 26 Cortlandt St., New York—Catalogue No. 72, illustrating and describing twinvolute turbine pumps. These pumps are small and compact, but still retain their strong and heavy construction. 6 by 9 in.; pp. 48.

Turret Lathes.

Niles-Bement-Pond Co., 111 Broadway, New York.—Well-printed catalogue illustrating and briefly describing the Pond turret lathe. This lathe is especially adapted to such work as gear blanks, flywheels, and gas engine cylinders. 9 by 6 in.; pp. 44.

Water Gauges.

Jerguson Mfg. Co., 221 Columbus Ave., Boston.—Catalogue D treats of reflex water gauges for marine and stationary boilers, locomotives and automobiles. Illustrated. 3½ by 7½ in.; pp. 26.

CLASSIFIED ADVERTISING SECTION

Rate, three cents a word per month. Minimum charge $1.00 per month. No electrotypes or illustrations; no display type. Cash with order. Forms close 20th of the month preceding date of issue.

Box numbers may be used and we will forward all replies. We will not give information about any advertiser using a box number. Correspondents answering advertisements may specify that their replies shall not be forwarded to certain persons or firms—thus avoiding possible embarrassment. Original letters of reference, etc., should not be sent to unknown correspondents; copies will serve the same purpose.

HELP WANTED

WANTED—A thorough Cost Accountant, who has had experience in handling the accounts of a perpetual Inventory Cost System; capable of opening Cost Ledgers and installing systems in large factories. State age, experience, references, and salary expected. None but those capable of filling high class position need apply. Address BOX 107, THE ENGINEERING MAGAZINE, 140 Nassau Street, New York.

CHEMISTS: Desirable openings for experienced chemists; various locations; salaries, $1000-$3000. Also positions for Architects, Draftsmen, Foremen, Superintendents, Engineers, Inspectors and Technical Specialists of all kinds. Offices in 12 cities. HAPGOODS, 305 Broadway, New York.

ADDING MACHINES

"GEM" ADDING MACHINE. 10 days' trial at our expense. Re-setting device clears the dials to zero instantly. Carries totals automatically. Adapted to all lines of business. Two year written guarantee. Price, $15.00. Write now for catalogue. AUTOMATIC ADDING MACHINE CO., Dept. 15, 332 Broadway, New York. 3-11

ADVERTISING NOVELTIES

We want every advertising manager in America to know us and we want to know every advertising manager. On receipt of request we will send you with our compliments a handsome souvenir. S. D. CHILDS & COMPANY, MAKERS OF ARTISTIC NOVELTIES IN METAL FOR ADVERTISERS, 200 Clark Street, Chicago. 6-11

AUTOMOBILES

"SUCCESS" AUTOMOBILE $250. The original motor-buggy. After eleven years labor by an engineer a perfect steel tired Auto. Runs 25 miles an hour, good hill climber. Write for particulars. SUCCESS AUTO-BUGGY MFG. CO., Inc., 532 De Baliviere Avenue, St. Louis, Mo. 12-6

BILL BINDER AND LOOSE LEAF HOLDER

THE KLIP BILL BINDER AND LOOSE LEAF HOLDER. No holes to punch. Instantly removable. Covers to order. Price list FREE. Sample dozen mailed for 75 cents. H. H. BALLARD, 150 Pittsfield, Mass. 5-11

BOOKS.

THE FACTORY MANAGER tells how to eliminate dead expense; unnecessary fixed charges; friction and delays; useless men, methods and records; unnecessary time and material; interruptions, "waits," and guess-work; too many handlings of work, etc., and how to arrive at exact cost of work done. Send for circular. THE ENGINEERING MAGAZINE, 140-142 Nassau Street, New York.

EVERY PRACTICAL ENGINEER should compile his own note book. Subscribe for Webber's tables, printed on 4x7" sheets, for insert binders. Every engineering subject, 25 cts. per sheet, printed both sides. Write for information to WILLIAM O. WEBBER, Consulting Engineer, 432 Exchange Building, Boston, Mass. 3-11

CARBON PAPER AND RIBBONS

WHITFIELD'S carbon papers are the non-smutty kind. Guaranteed to keep in any climate. Colors, black, blue, purple, green or red, at 50c. a book of 25 sheets, for either pen, pencil or typewriter. Liberal terms to agents. WHITFIELD CARBON PAPER WORKS, 123 Liberty Street, New York. 6-12

COPYHOLDERS

"RIGHT-IN-SIGHT" COPYHOLDERS have a joint arm as flexible and universally adjustable as the human arm. You can use them with any make of typewriter or adding machine. Send to-day for further information. COMBINED TOOL CO., Leominster, Mass. Agents Wanted. 6-11

IMITATION TYPEWRITTEN LETTERS

HIGH GRADE LETTERS by prepaid express to any part of the world. Write on your letter head for samples and prices, stating quantity desired. MYERS' LONG DISTANCE PRINT SHOP, New Orleans, La.

OFFICE CABINET

OUR NO. 100 OFFICE CABINET is made of golden oak, has adjustable shelves, and is five feet high, thirty-four inches wide and twenty inches deep. The adjustable feature permits arranging the shelves to accommodate any particular size books, letter heads, envelopes, catalogues, advertising matter, price lists, supplies, etc. We deliver this cabinet to your station all charges prepaid for $12.50. QUEEN CITY FURNITURE FACTORY, Market St., Shreveport, Louisiana. 4-12

PATENTS

I SELL PATENTS. To buy or having one to sell write CHAS. A. SCOTT, 1020 Granite Bldg., Rochester, N. Y. 6-11

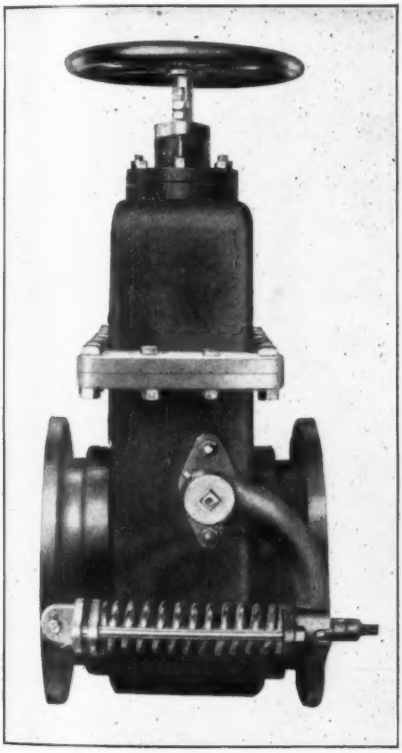
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Erwood Straightway Swing Gate.

THE Erwood valve possesses new and valuable features, being an embodiment of the features of a gate and check valve in one, and capable of performing not only the functions of each, but offering a wide degree of adaptability and application. As an ordinary back pressure valve, it is noiseless in operation—it can be placed in



any position—it can be thrown in and out of use by simply turning the hand wheel (as in a common gate) without disturbing its adjustment—is straightway, full opening and has neither compression pots nor weights—it is brass faced and bushed on valve and seat—it is not governed by gravity and will work as effectively in one position as another. The faces of valve and seat are flat—consequently self-cleaning in passing one over the other.

As an automatic relief for condensing and turbine engines, it is fitted with gauge glass and ball cock feed from the circulating or feed pump—is fully submerged. This feature of a submerged swing gate is fully covered by patent. Such an arrangement requires no attention from the engineer, and is automatic.

As a check valve for water, it permits the current to be reversed under pressure, at a moment's notice. It is intended for use in feed pipes, suction lines, and as a check and gate generally. For heavy suction service where much labor and complete disablement of the entire service are involved, this valve will remove one of the annoying features surrounding the ordinary foot and check valve. When obstructions and dirt pass through the strainer, they can be removed by drawing the valve over the seat into the bonnet, which will wipe or shear off any foreign matter or sticks which prevent its closing.

As a shut-out gate where a number of engines, pumps, and steam hammers, etc., exhaust into the same main, it is valuable as a safe-guard in preventing accident by water where the engines should be started before the gate is opened. The cylinder cannot be filled with water backing up from other units and yet can be warmed up and started first before the exhaust gate is opened. It is manufactured by Walch & Wyeth, 87 E. Lake St., Chicago, Ill.

The Dake Steam Turbine.

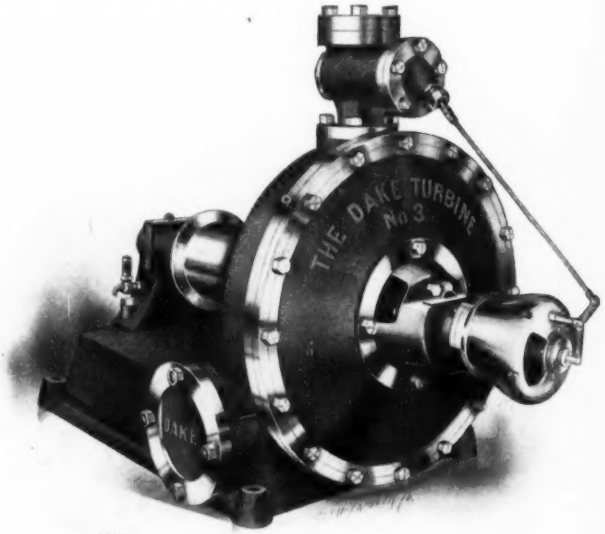
THE Dake steam turbine illustrated herewith is the result of experiments by Charles W. Dake, conducted with a

view to overcoming the defects of the vane-bucket. In the form adopted the buckets are milled out of the solid metal,—there are no vanes to crystallize and break off and no parts to work loose such as are found in some types of turbines. The shape of the space in the curved wall of the bucket is such as to bring the points of resistance to the steam nearer to the mouth of the nozzle and reduce the loss of energy in the flow of steam from the nozzle to the bucket. The buckets always

present the same angle to the flow of steam, —an angle such as to conserve the energy of the steam to the greatest degree possible. This method of delivering the steam removes the possibility of shock when the steam enters the buckets and consequently no erosion can occur through the impact of the steam against the wall of the bucket; neither can injury arise through the use of highly-superheated steam. Dake steam turbines are made in sizes up to 50 h.p., and are built either single-stage or multiple-stage. In sizes above 50 h.p. they are all of the multiple-stage type excepting when designed for certain special purposes. The considerations governing the choice between the single-stage and multiple-stage types are wholly those of economical use, based upon existing conditions.

The nozzles are so designed that the steam is delivered to the buckets in a parallel column, the walls of the nozzles being at an equal distance apart throughout their length. The expansion of the steam is accomplished by means of an "expansion wedge" set centrally in the nozzle. This wedge may be readily removed and replaced, and it is therefore easy to insert a wedge properly proportioned to give the highest efficiency possible with the steam pressure used.

The Dake turbines differ from some well-known types in that they may be operated advantageously at a moderate speed. They are, therefore, readily adapted to the driving of electrical generators by direct connection. The builder of generators for use with this turbine is not called upon to sacrifice anything in the way of electrical design or construction in order to adapt the generators to the turbine speeds. The same principles of construction which make this turbine superior to others for use with electrical generators operate to make it highly desirable for use in driving centrifugal pumps, blowers, etc. They can



also be run at speeds low enough to admit of belt drive.

The builders are the Dake-American Steam Turbine Co., Grand Rapids, Michi-

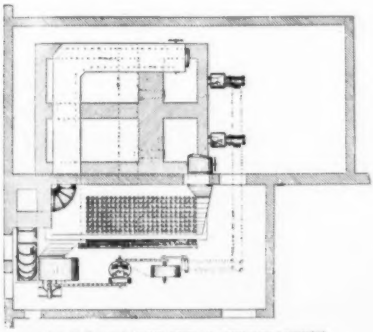
gan, who have issued a very interesting booklet on steam turbines, which they will send to those interested in the subject.

The Jones Stoker in Laundries.

THE German-American Laundry of Buffalo employs two 150 h. p. return tubular boilers, equipped with Jones stokers. Both forced and induced draft are used, the blowers being driven by a single Jones-Troy engine, whose speed is regulated by a Foster regulating valve. Instead of the usual belted connection between the engine and two blowers a "Silent Chain" drive is used. A Green fuel economizer also forms part of the boiler-room installation.

The operation of the equipment and results obtained therefrom are as follows:

The speed of the engine being regulated in accordance with the steam demands, the forced and induced draft as well as the



BOILER ROOM LAYOUT, GERMAN-AMERICAN LAUNDRY

fuel supply are regulated also in accordance with the requirements of the plant. The regulation of the fuel supply combined with the proper proportioning of the air supply is made possible by the use of the Jones stoker, which in this instance is equipped with the Cole automatic attachment, the valves operating the stoker ram being driven by connection with the blower, the speed of which is increased or diminished as the speed of the blower engine increases or diminishes. This regulation is secured because as steam approaches the blowing off point the Foster valve reduces the speed of the engine, which in turn reduces the speed of the forced and induced draft fans, and likewise reduces the fuel supply. As steam falls the Foster valve increases the speed of the engine which fact immediately increases the air supply and fuel supply sufficiently to maintain the desired steam pressure. After passing through the boilers, the escaping gases are drawn through the Green fuel economizer by the induced draft fan.

Owing to the fact that both the forced and induced drafts are operated by one engine, and further, that the relative outputs of the forced and induced draft blowers are in proper proportion, an absolutely correct amount of air is supplied to the furnaces and the heat generated is utilized to the best possible advantage. If the load in this plant were constant, there would be no variation in steam pressure as long as the fireman kept a sufficient supply of coal in the hoppers. As it is, his duties are greatly lessened as they consist solely in keeping the hoppers filled and in cleaning the fires at such intervals as may be necessary.

By the use of this system of mechanical firing, fuel is introduced to the furnace at any point therein that may be desired. This fuel cannot escape until it has yielded all the heat units that it contains. The forced draft blower supplies the air for combustion in accordance with the demands for steam and therefore necessarily in the proper amount. The heat generated in the furnace is distributed to the heating surface of the boiler by means of the induced draft blower, the speed of which also is regulated in accordance with the demands for steam.

Increasing Use of Graphite Paint.

EVEN the most casual observer cannot have failed to notice that within the past decade there has been a very radical change in the color of the coatings applied to railroad bridges, viaducts and other steel structures for the purpose of protecting them from corrosion and the elements. The change has been from reddish brown to grayish black. And the reason for this is that the most exhaustive research has disclosed the fact that the natural form of carbon—graphite—is the pigment best meet-

ing all of the many and varied requirements essential to the production of paint that will effectually protect under all conditions the surface which it covers. Graphite is an inert substance absolutely unaffected by extreme heat, frost, steam, water, sulphur fumes, acids, alkali, brine, or, in fact, by any climatic or chemical condition and these properties, together with its natural affinity for oil, its ability to withstand extremes of temperature, its density, the ease attending its application and the resulting saving of labor, its remarkable covering power and the consequent reduction in first cost, and its long life renders it the ideal paint for either the primer or weather coats.

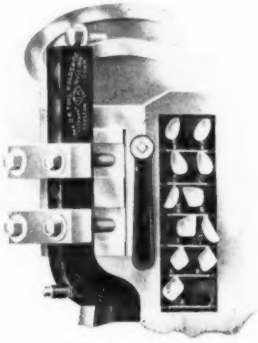
But to give this service in the greatest degree it must be pure, finely pulverized and thoroughly ground in the best of linseed oil. Graphite paint, then, is desirable in exact proportion with its purity and to be of unquestionable quality its pigment should analyze not less than 85 per cent. graphitic carbon of the amorphous variety —preferably Mexican graphite, the remaining 15 per cent. to consist principally of such silica as is naturally carried by the ore from which it is ground. This at least seems to be the consensus of opinion among authorities in railroad painting and as the railroad world is always alert to take advantage of new ideas which can be shown to save time and money and give best results, any radical departure from the beaten path is always first noticeable in railroad equipment to be ultimately copied as the standard of excellence by the smaller consumer, hence the gradual change from reddish brown to grayish black above referred to in the color of railroad bridges is now apparent everywhere in our manufacturing districts.

There are to-day on the market many so-called graphite paints, but neither the brand of the paint nor the reputation of the maker should be taken as prima facie evidence of quality. The careful buyer will insist upon the manufacturer's guaranteed analysis.

The United States Graphite Company, Saginaw, Mich., miners of graphite and manufacturers of graphite paint, have printed a very interesting booklet "About Graphite Paint" which upon request will be sent to those interested in this subject.

The O K Tool Holder.

THE system of lathe, planer, shaper, and boring-mill tool holders illustrated herewith offers all the advantages of a solid forged cutting tool combined with the most economical use of steel, particularly the use of the high priced high-speed steels. A shop equipped with these holders can practically do away with all forging by keeping a supply of these tools in stock. They can be ground and kept up by the tool-room, while the operator of the machine is always kept at his work and can have duplicate tools always ready by his side.



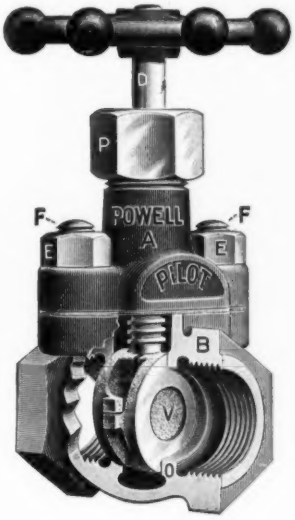
If he is doing work that requires several shapes of tools to finish he can by a quarter turn of the nut release the tool in the holder and place a new tool without changing the position of the holder on the work. These tools are hydraulic and drop forged from the best grades of high steel and other steels and are correctly ground and tempered. The illustration herewith shows the standard planer set.

The O K Tool Holder Co., Shelton, Conn., will furnish full illustrated description of all designs on request.

New Powell Valve.

THE "Pilot" iron body gate valve is another addition to the list of steam specialties manufactured by the Wm. Powell Co., Cincinnati. The illustration shows a strong, compactly built valve with every detail carefully worked out. The iron body is built for service and is designed with heavy lugs on each side of the neck carrying stud bolts. The bonnet cap has corresponding lugs drilled to tem-

plate, which insures a perfect joint and constant alignment at all times and also allows the bonnet to be replaced without unusual care after taking apart for inspection or repairs. Two semi-finished hexagon nuts large enough to admit wrenching down hard, with a joint of the best packing material between the faces of bonnet and body, make an absolutely tight joint for all pressures up to 100 lbs. The large brass packing nut affords plenty of room for packing material to prevent leakage around the stem. The brass stem and bonnet are chased and cut to a true Acme thread of unusual length. The length of thread keeps the stem in a true axial position at all times whether open or closed. The knobbed hand wheel gives a firm grip, even though the hands may be oily. The discs are double, not a single wedge, with ball and socket back, making them adjustable. They are hung in recesses to the collar on the bottom of the stem. The discs, working in a tapering seat, expand or collapse in opening or closing, making a valve that will close down tight without straining or open easily, no matter what the conditions may be. The Powell pilot gate valve is also made all iron, that is, discs, stem and packing nut are of iron, not a particle of brass being used in its construction. This all iron pilot gate valve will be found especially valuable in controlling ammonia, cyanide solutions, acids and all other liquids or gases that attack brass.



Planer Clamp.

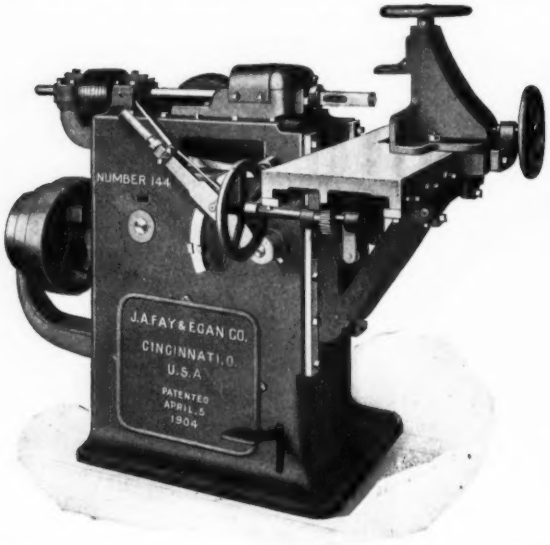
J. H. WILLIAMS & CO., Brooklyn, have placed on the market a "planer clamp," designed for use as a clamping head in all kinds of lathe, planer, drill press, milling and boring machine work. The design has been approved by several large and reputable machine tool makers. The clamps are made from a selected tough high-carbon steel and after forging they are subject to a special treatment which

adds materially to their stability. The oval hole permits considerable adjustment. At present they will be made in three sizes, varying from 4 to 8 inches in total length.

A New Hollow Chisel Mortiser.

THIS new automatic hollow chisel Mortiser is a medium sized machine, designed for use in car shops, furniture, carriage, wagon, sash, door and blind factories and is presented to the trade with confidence and assurance of an up-to-date tool. It is simple, effective and durable. The capacity of the machine is 8 inches wide by 8 inches thick and it will mortise from a half inch to one inch square and to a depth of 7 inches. The bits are fixed to a reciprocating frame moving in planed slides on the top of the column. The depth of the mortise is regulated either by the adjustment of the table or the adjustment of the stroke. The chisel is driven by elliptic gears which give it a quick return at the completion of the mortise. The foot

treadle at the base of the machine governs the chisel thrust. The stroke is variable by changing the position of the crank pin on the crank arm. The table is 40 x 8½ inches, is counterbalanced, and has a vertical adjustment of 6 inches by means of a lever provided with stops by which one or more mortises can be made as in double mortising. It has an adjustment endwise for regulating the length of the mortise by a hand wheel operating a rack and pinion.



Further information regarding the tool may be had from the manufacturers, J. A. Fay & Egan Co., 212-232 West Front Street, Cincinnati, O.

Iron Cement in the Foundry.

A NUMBER of years ago the foundry trade became aware of the extreme need of a chemical compound that would be easily applied to fill cracks, blowholes and various blemishes and defects in iron castings and in this way so completely repair them as to do away with any chance of detection. Recognizing this need the S. Obermayer Co. set its chemical and experimenting departments at work and the result was a compound known as National mix a sufficient quantity of it with compound and making the necessary experiments toward perfecting it, it was found that several things were required to make this compound what was needed by the foundry trade. In the first place, such a compound should metallize practically as hard as the iron itself, and it should also expand while metallizing so as to completely fill any opening into which it was introduced and at the same time force itself into the grain of the iron. National iron filler cement is put up in powdered form and is very easy to use. In use the foundryman has simply to mix a sufficient quantity of it with enough water to make it the consistency of stiff putty and press it firmly into the crack or crevice to be repaired. After this is done it is smoothed over with a knife and the casting is just as good as if no defect has ever occurred. After a casting has been repaired in this manner it can be machined regardless of the existence of any previous imperfection.

The Obermayer Co. will send a liberal sample of this material to anyone sufficiently interested to write for it to either of their Cincinnati, Chicago, or Pittsburg offices.

NEWS SUPPLEMENT

The Engineering Magazine—December, 1907

Personal.

—Percy H. Thomas and N. J. Neall announce the formation of the firm of Thomas & Neall, electrical engineers, with offices at 52 William St., New York, and 12 Pearl St., Boston.

—Edwin J. Peirce, Jr., has sold out and severed his connection with the Taft-Peirce Mfg. Co., of Woonsocket, R. I. Mr. Peirce was the leading spirit in the organization of this company in 1894 and was in charge of its rapid growth until 1904—since which date he has been retained by the new management in a consulting capacity only. Mr. Peirce's plans for the future are not known, but he can be addressed at Woonsocket.

Industrial Notes.

—The Sullivan Machinery Co., Chicago, announce that their Birmingham office is now located at 1 Twentieth Street, South.

—The Revolute Machine Co., New York, are distributing a little pamphlet giving a list of the first 100 users of their blue print machine. Also contains numerous testimonial letters from recent purchasers.

—W. & B. Douglas, Middletown, Conn., announce that they have acquired the pump department of the Union Mfg. Co., New Britain, Conn., and will continue the manufacture of their pumps in Middletown.

—The New York, New Haven & Hartford Railroad is now running its thirty-five Westinghouse electric locomotives with local trains between the Grand Central Station, New York, and Stamford.

—The American Blower Company, Detroit, had an interesting exhibit at the recent annual conventions of the American Street and Interurban Railway Association and its allied associations at Atlantic City.

—James L. Farmer, secretary of the Jury of Awards, Jamestown Exposition, has notified the General Electric Company that it has been awarded two gold medals and a bronze medal on account of its exhibit at the Exposition.

—At the Buffalo Convention the Century Cement Machine Co., Rochester, will exhibit for the first time the Hercules concrete mixer, which A. T. Bradley has solved the problem of properly proportioning and mixing concrete.

—Probably the largest and heaviest metal working planer ever built, has recently been shipped from the Bement-Miles Works, Philadelphia, to Mackintosh, Hemphill & Co., Pittsburgh. The total weight of the machine is 845,000 pounds.

—The reference libraries of The American Institute of Electrical Engineers, The American Society of Mechanical Engineers, and the American Institute of Mining Engineers, 29 West 39th Street, New York, are now open evenings until nine o'clock on all week days except public holidays.

—At the University of Wisconsin, the Chair of Electrical Engineering, recently made vacant by the resignation of Professor Dugald C. Jackson, who is now in charge of the department of electrical engineering at the Massachusetts Institute of Technology, has been filled by the appointment of Orville H. Ensign.

—The current number of the Obermayer Bulletin is devoted exclusively to the core room and contains a number of well written articles on this subject, besides showing numerous modern appliances for getting the largest amount of work with the smallest outlay. Copies may be had free by writing The Obermayer Bulletin, Cincinnati.

—In the development of Japan the progressive Japanese make it a point to purchase nothing but the most up-to-date material. The Japanese were among the very first to anticipate that the turbine engine was to be the foremost power producer of the age and as a consequence a great many American turbine engines have been installed in that far away country. A total of 69 units, aggregating 60,000 horse power capacity, of the Curtis type of turbo-gen-

erator, manufactured by the General Electric Co., Schenectady, N. Y., have been installed in that country.

—J. H. Wagenhorst & Co., Youngstown, report among recent sales of their electric blue printing machines, the following: Eugene Dietzgen Co., Toronto; H. W. Caldwell & Son Co., Chicago; Betts Machine Co., Wilmington; Green Fuel Economizer Co., Matteawan, N. Y.; Atlantic Terra Cotta Co., Tottenville, N. Y.; Kansas City Structural Steel Co., Argentine, Kansas; Sawyer & Garstin, Colorado Springs; H. Vogt Machine Co., Louisville; S. G. Fetterman Engineering Co., Johnstown, Pa.; American Locomotive Works, Schenectady; H. L. Sprague, Springfield, Mass.; R. M. Jones Co., Muskogee, I. T.; Ajax Forge Co., Chicago; Toledo Machine & Tool Co., Toledo.

—The Public Library of the District of Columbia has opened a special room in which will be found on open shelves its books and current magazines on the useful arts and most of its scientific books. These will include engineering, electricity, physics, chemistry, manufactures, architecture, building, carpentry, gas-fitting, plumbing, wood and metal working, automobiles, railroads, telegraphs, telephones, printing, shorthand, bookkeeping, accounting, and the trades and business generally. A collection of manufacturers' catalogs is being gathered and they would be pleased to receive copies of all new catalogues for filing purposes as soon as issued. The room will seat 50 persons and will be in charge of men.

—The Fifty-fourth Annual Meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies Building at 29 West 39th Street, New York, December 3-6, 1907. Symposiums on foundry practice, giving the experiences of prominent men in that work, have been arranged. The specific heat of superheated steam will be taken up, a very important and exhaustive work by a Professor of Engineering at Cornell will be presented. The utilization of low grade fuels in gas producers, combustion control in gas engines, tests of producer gas engines, etc., will be given a session. Other live topics, such as industrial education, power transmission by friction driving, cylinder port velocities, etc., will be discussed.

—The Westinghouse Electric & Mfg. Company report among other contracts taken by the company, two from the republic of Columbia, South America, are of more than ordinary interest. This work calls for the complete equipment of two city electric lighting plants. One is for the city of Tunja and the other for Bucaramanja. Tunja is located 9,000 feet above the level of the sea in the Columbia mountains, while Bucaramanja is located two thousand feet lower down the slope. The electric plant for the former will be steam driven, but at Bucaramanja is a splendid water power and the plant will be operated in that manner. A peculiar feature of this mountainous country is that the mule back is the only method of transportation, and all the apparatus, boilers, steam engines, electric generators, switchboard appliances, etc., will have to be hauled from the seaport up into the mountains on mule back.

—A booklet which should prove useful to everyone who sells electric motors or motor-driven machinery to the Navy Department has just been issued by The Cutler-Hammer Mfg. Co., Milwaukee, makers of electric controlling devices. This company for many years has made a special study of Navy Department requirements and in the booklet just issued full descriptions, illustrations, dimension diagrams and shipping weights are given on starting panels, speed regulating panels, machine tool controllers, resistances, circuit breaker panels, etc. In the preface to the booklet in question attention is called to the fact that Navy specifications preclude in nearly all instances the use of ordinary controlling panels and, furthermore, that apparatus acceptable for use in navy yards will not always be acceptable if supplied for use on shipboard. How to select the proper piece of apparatus in each case is fully explained, and in addition to numerous illustrations of electric controlling appliances conforming to Bureau of Construction and Repair and Bureau of Equipment specifications, the booklet includes several views of battleships equipped with Cutler-Hammer control.

NEW CATALOGUES AND TRADE PUBLICATIONS

NOTE—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page 11.*

Centrifugal Pumps.

LAWRENCE PUMP & ENGINE CO., Lawrence, Mass.—Catalogue A 1, illustrating and describing pumping machinery, together with tables giving dimensions, prices, etc. 6 by 3½ in.; pp. 32.

Coal Handling Machinery.

JEFFREY MFG. CO., Columbus, O.—Catalogue D treats of coal and ashes handling machinery for power plants, and is illustrated with views showing many recent installations. 6 by 9 in.; pp. 50.

Die Castings.

H. H. FRANKLIN MFG. CO., Syracuse.—Catalogue describing the almost endless number of uses to which die cast parts are adaptable, such as electrical apparatus, automobiles, adding and calculating machines, time stamps, time recorders, and every device requiring small intricate parts. Illustrated. 8 by 4¾ in.; pp. 24.

Drop Forgings.

ANDERSON FORGE & MACHINE CO., Detroit.—Well-printed booklet illustrating and describing drop forgings, steam hammer forgings, finished crankshafts, automobile tools and cold chisels. Also contains notes on vanadium steel. 3¾ by 8½ in.; pp. 24.

Electrical Equipment.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Bulletins Nos. 4530, 4532, 4533, 4534 and 4538 illustrate and describe mercury arc rectifiers, direct-current motor-starting rheostats, Wright demand indicators, Curtis steam turbines and catenary line material.

Fans.

MASSACHUSETTS FAN CO., Watertown, Mass.—Catalogue, pocket size, illustrating and describing heating, ventilating and drying fans, blowers and engines. Lengthy descriptions have been avoided, and the catalogue is devoted almost wholly to illustrations, dimension tables, capacity tables, engineering tables and explanatory notes. 7 by 4 in.; pp. 100.

Feed-Water Heaters.

NATIONAL PIPE BENDING CO., New Haven, Conn.—Catalogue illustrating and describing feed-water heaters. Also contains tables giving details and dimensions. 5 by 8 in.; pp. 24.

Fuel Economizers.

GREEN FUEL ECONOMIZER CO., Matteawan, N. Y.—Booklet, the first part of which is devoted to a reprint of an article by Herr C. Eberle of Munich on "The Influence of Boiling by Steam in the Boiler Plants of Breweries," in which it is shown that the highest economy is reached only when both the exhaust steam from the different machines about the brewery and the waste gases from the boiler furnace are utilized for producing hot water. The second part of the pamphlet takes up the use of warm or cold and moistened air for promoting germination, and the use of hot dry air in the malt kiln. By utilizing blowers to move this air, much quicker and better results may be obtained than by methods relying upon natural draft. It is also possible to run the plant to full capacity at all times of the year and in all conditions of weather. 6 by 9 in.; pp. 16.

Filing Cabinets.

GLOBE-WERNICKE CO., Cincinnati.—Catalogue No. 808 illustrates and describes, with prices and dimensions, "elastic" filing cabinets, vertical filing cabinets and solid filing cabinets. 6 by 9 in.; pp. 100.

Flanged Fittings.

DIRECT SEPARATOR CO., Syracuse.—Catalogue illustrating standard and extra heavy flanged fittings, together with tables giving prices, sizes, etc. 5 by 7 in.; pp. 36.

Lifting Magnets.

CUTLER-HAMMER CLUTCH CO., Milwaukee.—Pamphlet treating the subject of lifting magnets fully. The booklet contains a number of full page illustrations showing lifting magnets handling pig iron, steel stampings, castings, scrap and other material, together with diagrams, data on consumption, information on lifting capacity of magnets, etc. 5 by 8 in.; pp. 32.

Mechanical Calculator.

AMERICAN MECHANICAL CALCULATOR CO., Cincinnati.—Pamphlet illustrating and describing the operation of the American mechanical calculator—by which machine labor costs are mechanically calculated. 6 by 9 in.; pp. 12.

Steam Engines.

ATLAS ENGINE WORKS, Indianapolis.—Bulletin No. 137 illustrates and describes splash oiling, single-valve high speed engines, especially designed for direct connection to electric generators, and all classes of work requiring high rotative speed and perfect regulation throughout wide ranges of load. 7¾ by 10½ in.; pp. 8.

Switch Controllers.

ELECTRIC CONTROLLER & SUPPLY CO., Cleveland—Booklet containing a reprint of a paper on magnetic switch controllers read before the Electrical Engineers of the Iron and Steel Industry at the Pittsburg meeting. October 10, 1907. Illustrated. 3 by 6 in.; pp. 28.

Tool Holders.

O. K. TOOL HOLDER CO., Shelton, Conn.—Catalogue illustrating and describing tool holders and tools for lathes, planers, shapers, boring mills, etc. 5 by 7½ in.; pp. 20.

Valves and Fittings.

CRANE CO., Chicago.—Cloth bound catalogue illustrating and describing, together with prices and sizes, valves and fittings for ammonia. Also contains many tables giving much valuable data. 4 by 7 in.; pp. 126.

CLASSIFIED ADVERTISING SECTION

Rate, three cents a word per month. Minimum charge $1.00 per month. No electrotypes or illustrations; no display type. Cash with order. Forms close 20th of the month preceding date of issue.

Box numbers may be used and we will forward all replies. We will not give information about any advertiser using a box number. Correspondents answering advertisements may specify that their replies shall not be forwarded to certain persons or firms—thus avoiding possible embarrassment. Original letters of reference, etc., should not be sent to unknown correspondents; copies will serve the same purpose.

HELP WANTED

OPPORTUNITIES: Current issue our monthly publication describes 500 positions now open for high grade Business, Professional and Technical men; sample copy free. Offices in 12 cities serving leading employers everywhere. Our absolutely confidential service is only means of keeping constantly in line for advancement. HAPGOODS, 305 B'way, N. Y. 12-6

SITUATIONS WANTED

ADVERTISING WRITER, with ability to write strong business getting copy and qualified to manage your advertising department, desires to connect with some good house; if your business is not large enough to warrant an advertising manager let me make you a proposition to handle what advertising literature you may need; I will act as your advertising adviser at a small amount each week. BOX 104, THE ENGINEERING MAGAZINE, 140 Nassau Street, New York.

TECHNICAL GRADUATE, 40, 16 years experience in engineering and manufacturing, desires position as Agent, Superintendent or Manager to go to Australia or New Zealand. Address "ENGINEER," Oakland Station, Box 64, Pittsburg, Pa. 1-12

GRADUATE Worcester Polytechnic Institute, 5 years' successful experience as erecting engineer, designer, engineering salesman and branch-office manager with large concern manufacturing general line of heating and power machinery, desires position with good opportunity for advancement. Address J. D. R., care ENGINEERING MAGAZINE, 140 Nassau St., New York. 1-12

AUTOMOBILES

"SUCCESS" AUTOMOBILE $250. The original motor-buggy. After eleven years labor by an engineer a perfect steel tired Auto. Runs 25 miles an hour, good hill climber. Write for particulars. SUCCESS AUTO-BUGGY MFG. CO., Inc., 532 De Baliviere Avenue, St. Louis, Mo. 12-6

BOOKS.

THE FACTORY MANAGER tells how to eliminate dead expense; unnecessary fixed charges; friction and delays; useless men, methods and records; unnecessary time and material; interruptions, "waits," and guess-work; too many handlings of work, etc., and how to arrive at exact cost of work done. Send for circular. THE ENGINEERING MAGAZINE, 140-142 Nassau Street, New York.

EVERY PRACTICAL ENGINEER should compile his own note book. Subscribe for Webber's tables, printed on 4x7" sheets, for insert binders. Every engineering subject, 25 cts. per sheet, printed both sides. Write for information to WILLIAM O. WEBBER, Consulting Engineer, 432 Exchange Building, Boston, Mass. 6-2

THE ENGINEERING INDEX ANNUAL for 1906 embraces all branches of engineering, and clearly indexes alphabetically by subject about 7,000 important articles of permanent value which appeared during 1905 in about 250 engineering journals, transactions and proceedings. Complete in itself for the period covered. We undertake to supply the full text of every article indexed in the original language, together with all accompanying illustrations. 416 pages, 9½ by 7 inches, cloth binding; $2.00 prepaid. Sent on approval. THE ENGINEERING MAGAZINE, 140-142 Nassau Street, New York.

CARBON PAPER

WHITFIELD'S carbon papers are the non-smutty kind. Guaranteed to keep in any climate. Colors, black, blue, purple, green or red, at 50c. a book of 25 sheets, for either pen, pencil or typewriter. Liberal terms to agents. WHITFIELD CARBON PAPER WORKS, 123 Liberty Street, New York. 6-12

CARBON PAPER IN ROLLS is the new money saving idea on high grade carbon paper. Tear off the exact length desired, no more. Absolutely no waste. We send the cases free, and supply you with fresh rolls, as needed. Costs no more than ordinary carbon paper. Saves one-third. Send for details regarding our special introductory plan today. TYPO-CARBON CO., Dept. E, Sheboygan, Wis. 1-12

OFFICE CABINET

OUR NO. 100 OFFICE CABINET is made of golden oak, has adjustable shelves, and is five feet high, thirty-four inches wide and twenty inches deep. The adjustable feature permits arranging the shelves to accommodate any particular size books, letter heads, envelopes, catalogues, advertising matter, price lists, supplies, etc. We deliver this cabinet to your station all charges prepaid for $12.50. QUEEN CITY FURNITURE FACTORY, Market St., Shreveport, Louisiana. 4-12

IMPROVED MACHINERY

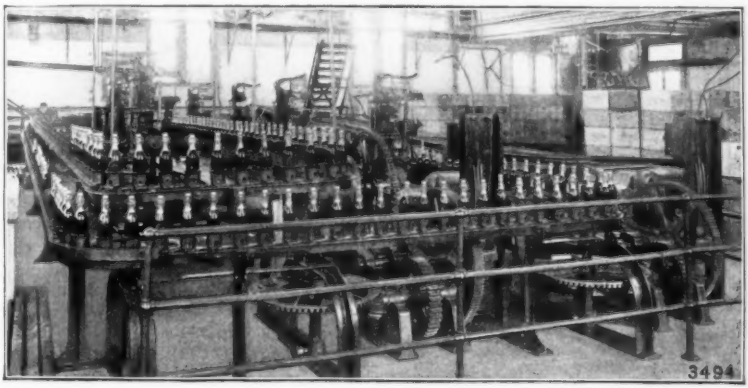
New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Bottle Conveying System.

A NEW bottle-conveying system having a capacity exceeding 20,000,000 bottles a year, was recently installed in the brewery of S. Liebmann's Sons, Brooklyn, New York, by the Philadelphia works of the Link-Belt Company. The general view of this installation (which was devised from plans by Adolph Liebmann), shows the bottles en route from the filling and capping machines to the labeling machines. The equipment comprises two horizontal chain conveyors made up of single-strand Ewart link-belt, and supplemented by two belt conveyors. The chain conveyors run on angle-iron tracks supported at intervals by the cast-iron frames shown in detail cross-section view. These frames are made in two styles,—one a combination chain and belt conveyor support, and the other to accommodate the side by side runs of both chain conveyors. The bottle-holders, of cast-iron and rigidly attached to the chain, are designed to permit quick, easy loading and, by a sufficiently snug fit, to assure safety in transportation.

The operation of the system is set forth in the diagram illustration: The chain conveyors traverse rectangular paths of different size, that followed by the larger or "outer" conveyor approximating 45 feet in length by 11 feet in width, the dimensions for the smaller (inner) conveyor being about 42 feet by 6 feet. The belt conveyors, before mentioned, parallel the labeling-run of each chain conveyor. As the bottles are filled and capped they are transferred manually to the chain conveyors for delivery to the labeling machines, four of which are served by the "outer" conveyor and two by the "inner" one. As they pass in front of the labeling operators attending



BOTTLING DEPARTMENT, S. LIEBMANN'S SONS' BREWERY, BROOKLYN, N. Y.

the outer conveyor, the first man picks up every fourth bottle, the operators at the succeeding machines each removing one of the remianing three; bottles are taken alternately from the inner conveyor. The labeled bottles are placed upon the contiguous belt conveyor and delivered to the casing department. The conveyors are driven by General Electric motors.

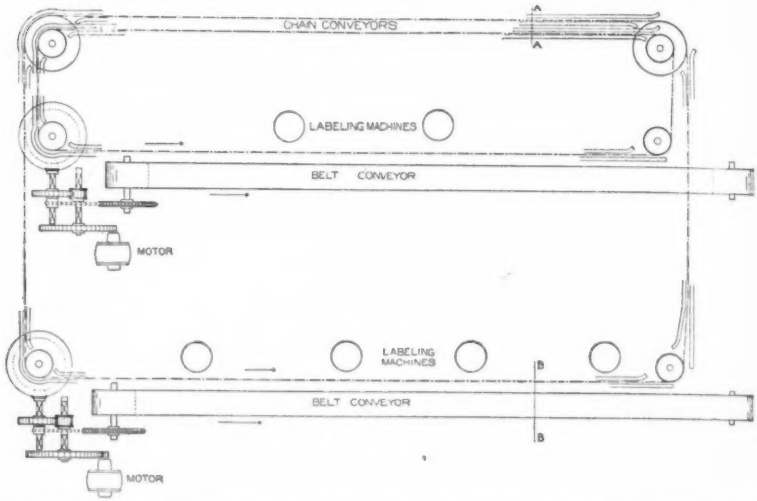


DIAGRAM SHOWING ARRANGEMENT OF CHAIN AND BELT CONVEYORS OF THE BOTTLE-CONVEYING SYSTEM.

Another Manufacturer of Big Gas Engines.

THE Wisconsin Engine Company, with works at Corliss, Wis., is now building gas engines for all services in sizes from 400 B. H. P. to 5,000 B. H. P. The engines utilize natural gas, producer gas, coke-oven gas or blast-furnace gas in the Otto cycle (4-cycle), and are of the horizontal tandem and twin-tandem double-acting type. This company controls the Sargent patents on internal combustion engines and has employed Charles E. Sargent as the engineer of its gas engine department. Mr. Sargent designed in 1898, it is claimed, the first horizontal tandem double-acting gas engine, which was a wide departure from the accepted practice of those days, when the most prominent manufacturers of gas engines declared such a type was impracticable, and doomed to failure. Dick, Kerr & Co., of Kilmarnock, built a few 4 and 6-cycle tandem engines previous to this date, but we believe their manufacture was discontinued. However, the largest and most successful gas engines are of the horizontal twin-tandem double-acting 4-cycle type, and with one exception this is the only type in which large units are being built in this country to-day.

The gas engines built by the Wisconsin Engine Co. bear some of the distinctive features of their big Corliss engines, and utilize in design most of the Sargent patents. The design is remarkably simple and embodies features which are of considerable interest to the engineer and power user, *e. g.*,—there is but one poppet valve for each explosion chamber, and as this is located on the bottom of the cylinder the cumbersome and unsightly air and gas pipes, as well as the stairs, galleries, and railings found on most horizontal tandem engines, are entirely eliminated. Provision is made for preventing the dangerous pressures caused by possible pre-ignitions, and the engines are started automatically. Tests of even small Sargent engines show a heat

consumption of less than 9,000 British thermal units per brake horse power hour.

This company has recently shipped some large steam engines to such concerns as the Illinois Steel Co., Jones & Laughlin Steel Co., Packard Motor Car Co., American Sheet & Tin Plate Co., Amoskeag Mfg. Co., New Hampshire Spinning Mills, National Tube Co., City of Milwaukee, Carnegie Steel Co., American Woolen Co., United States Envelope Co., and the Carnegie Natural Gas Co., and has built up a reputation for shipping "on time."

Commutator Truing Device.

POWER station engineers have rigged up numerous kinds of appliances for truing and turning commutators on large machines where it is impractical to remove the armature for the purpose. There are few appliances on the market for this work, therefore the new commutator truing device manufactured for The Patterson Tool & Supply Company of Dayton, and illustrated herewith, is of general interest. The device is designated to be bolted to the subbase of the generator and the commutator trued by revolving the armature slowly while the tool is fed in and across the face of the commutator. As will be noticed from the illustration, the device comprises a base carrying a split sleeve in which the column supporting the tool rest is adjusted. Both cross and longitudinal feed are provided, being hand fed. The tool has a longitudinal feed of 15 inches, a cross feed of 5 inches and a vertical adjustment of 6 inches. A ⅜ in. x ¾ in. tool is used. The weight of the machine is 75 pounds.

COMMUTATOR TRUING DEVICE.

Data Sheets

WILLIAM O. Webber, consulting engineer, Boston, has prepared a series of data sheets, 4 x 7", perforated for insertion in private note books, and designed to save to the engineer and designer the time usually required to look up in engineering note books and digest the information contained in them, then ascertain which of the many formulæ fits a given case, and then figure out the results. The object of the sheets is to provide tables of average results based on average conditions and average experience, supplemented by a chart from which any results can be obtained between those stated in the tables.

One of the tables refers to leather belting, and is based on the result of investigations which show that in well tanned leather belting, from the back of hides, a square foot weighs exactly an ounce for each 100th of an inch in thickness, and that the safe working strain upon such belts is 330 pounds per square inch, which should be equal to 3⅓ pounds per ounce in weight.

The shafting table, for line shafts, is based on the formula $D = \sqrt[3]{\frac{50 \times H.P.}{R.P.M.}}$ for iron shaft, with factors for converting the results into prime movers, 3rd movers, and for steel shafts. The capacity of chimneys is figured on the basis of four pounds of coal per hour, and the formula $H.P. = 3.33 (A - 0.6 \sqrt{A}) \sqrt{H}$. The gear table based on the formula $H.P. = 5\ V.\ T.^2$, and the face of the tooth being pitch x 2½.

A table giving the horse power of dry steam, air and other gases which can be conveyed through long pipes, based on $Q = 4.7233 \sqrt{\frac{H}{L}} d^5$, and in which the friction is figured on L. H. $= \sqrt[5]{\frac{Q^2 L}{H}}$. A table

on the losses in pressure by velocity of compressed air, or other fixed gases, in pipes, based on D'Arcey's formulæ. Tables giving the factors for converting pipe and boiler tubes from lineal to square feet, and vice versa, based on actual measurements.

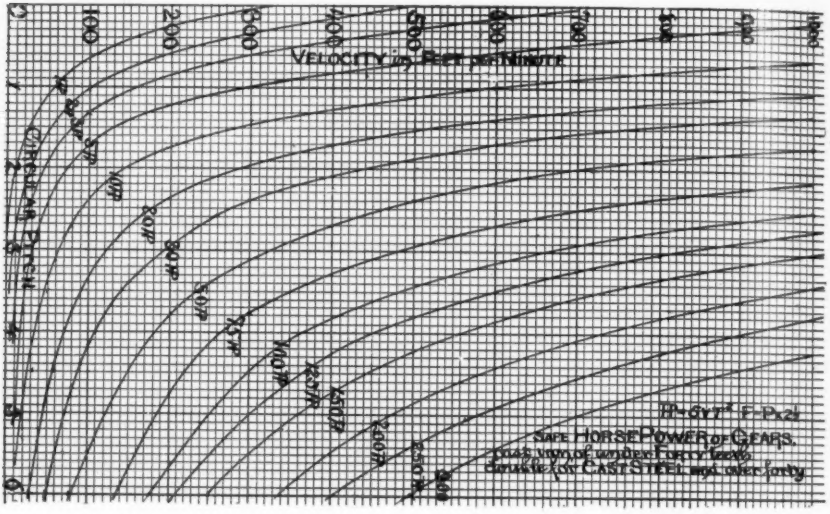
A table giving the cost of pumping in million gallons of water per 24 hours to one foot in height, based on the average reports for 8 or 10 years from the returns to the New England Water Works Association.

A table giving the capacities, speeds and horse powers of disk ventilating fans, based on actual tests, carefully corrected.

A table giving the costs of power per brake horse power per hour from 1 to 100 horse power for steam, electricity, gas and gasoline, based on the writer's experience of twenty-five years in building and operating such plants, and tabulating the returns, and including all expenses, such as interest and taxes on land, and buildings, usually left out. Another table giving the consumption of steam in pounds per indicated horse power per hour, for all types of engines, based on many tests by the best authorities, and the writer's experience in building and testing many thousands of steam engines.

It is a very interesting fact that, in all of the tables in which horse power is the result, the curves invariably arrange themselves in geometrical ratio one to another, no matter what the form of the curve may be, or even if they are straight lines.

It is the intention to supplement the list of subjects enumerated above with others if the demand for the present sheets will warrant it. They are prepared by William O. Webber, 432 Exchange Building, Boston, Mass.



Test of Centrifugal Pumps.

THE following is a test of two 36 in., Class B, Lawrence Machine Co. centrifugal pumps driven by Atlas engines, at the pumping plant of the Grand Central Co., Iota, Louisiana. These tests were made by W. B. Gregory, professor of experimental engineering, Tulane University, Louisiana, for the United States Department of Agriculture.

The two pumps were of the same size, and were each equipped with open impellers 62 in. in diameter and 8 in. wide at the point of the blades. The diameter at the throat of the volute, where the tapering discharge begins, was 28 in. Each pump was equipped with two suction pipes 24 in. in diameter, enlarging to 34 in. at a distance of about 4 ft. from the flange of the

elbow entering either side of the pump. To these again were attached conical pipes 9 ft. in length, with a lower diameter of 42 in.

The discharge pipes on each pump are provided with taper connections, enlarging to 44 in., which are further enlarged to 51 in., thus reducing the velocity of the discharge water and accelerating the velocity of the entrance water to the pump in a uniform manner.

The engine driving one pump is an Atlas 14 x 20 x 24 in. The pumps were driven by 16 strands of 1¼ in. rope:

SIMPLE ENGINE AND PUMP, SEPT. 20, 1906.

N	H + h	G.P.M.	W.H.P.	I.H.P.	n_t	B.H.P.	n_1	v_t	C_1	$C_1 \div \sqrt{2gh}$
174.8	31.84	42980	345.2	509.8	67.7	432.5	79.8	22.4	47.35	1.046
174.8	31.85	44520	357.5	513.4	69.6	436	82.	23.2	47.35	1.045
175	31.85	45210	363	497	73	422.5	85.8	23.5	47.4	1.046
175.2	31.85	43580	350	502.9	69.6	427	82.	22.45	47.45	1.047
163.8	31.65	31550	251.8	360.9	69.8	306.5	82.1	16.42	44.35	0.984
163	31.63	31140	248.3	357.4	69.5	364	81.8	16.22	44.18	0.979
169.8	31.73	36980	295.8	424.7	69.7	363	81.5	19.25	45.95	1.023
157.4	31.44	19870	157.3	256.9	61.3	218.2	72.	10.35	42.65	0.95
157.4	31.44	20200	160	248.9	64.3	211.5	75.7	10.51	42.65	0.95

N = Revolutions per minute.
H + h = Static head plus friction head.
G.P.M. = Gallons per minute.
W.H.P. = Water horsepower.
I.H.P. = Indicated horsepower of engine.
n_t = Combined mechanical efficiency of pump, engine, and rope drive.
B.H.P. = Brake horsepower delivered to pump shaft.
n_1 = Mechanical efficiency of pump alone.
C_1 = Velocity of periphery of impeller in feet per second.
$C_1 \div \sqrt{2gh}$ = Ratio of velocity of impeller to the velocity due to gravity.

2-36 IN. CLASS B PUMPS AT IOTA, LOUISIANA.

COMPOUND ENGINE AND PUMPS, SEPT. 21, 1906.

N	H + h	G.P.M.	W.H.P.	I.H.P.	n_t	B.H.P.	n_1	v_t	C_1	$C_1 \div \sqrt{2gh}$
169.4	31.47	35780	284	427	66.5	363	78.3	18.55	45.8	1.02
160.4	31.49	29720	235.9	376.3	62.7	311	75.8	15.5	43.45	0.965
167.5	31.56	38620	307.1	440.8	69.7	374	82.1	20.1	45.35	1.005
168.7	31.57	39650	315.7	450.9	70	383	82.5	20.65	45.65	1.012
168.3	31.65	39600	311.2	441.8	70.5	375	83	20.3	45.6	1.01
168.5	31.67	38430	306.8	439.9	69.8	373	82.3	20.+	45.63	1.011
168.3	31.70	37090	296.4	442.5	67	376	78.8	19.3	45.55	1.01
167.9	31.74	36760	294.1	426.2	69	362	81.25	19.15	45.45	1.006
168.5	31.75	37530	300.3	437	68.7	371.5	80.9	19.55	45.63	1.01
186	31.87	51870	416.7	640.5	65	545	76.5	27.	50.4	1.112
169.3	31.66	38445	308.8	452.3	67.89					

DUTY SEPT. 21, 1906, INCLUDING AUXILIARIES.

$$\frac{38.445 \times 1440 \times 8.34 \times 31.66}{452.3 \times 17.7 \times 24} \times 1000 = 76{,}400{,}000 \text{ ft. lbs. per 1000 lbs. of steam.}$$

Evap. 12.56, Duty for 100 fuel = 96,000,000 pump and engine.
" " " " 106,000,000 pump alone.
Main pump alone 16 (Assumed) = 84,500,000 per 1000 lbs. of steam.
Imp. Diam. 62 in.
Imp. Width 8 in.
Pump Throat 28 in.

The Lawrence Machine Co., Lawrence, Mass., the manufacturers of this pump, will be pleased to furnish further information on request.

Centrifugal Compressors for Air Blast.

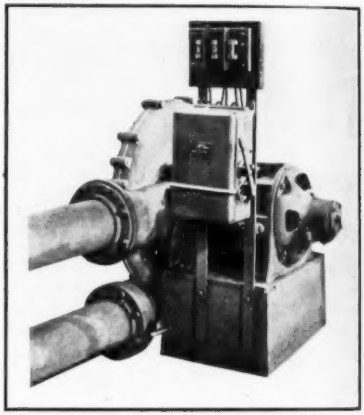
AFTER an extensive series of experiments covering a number of years the General Electric Company is now producing a line of direct-connected units for supply of air at moderate pressures in large quantities. These units are principally adapted for air blast for burning fuel, such as in oil, gas, or other furnaces for various industrial purposes, such as hardening, soldering, annealing, melting, smelting, etc., for machine shops, factories using gas and oil furnaces, gas works, copper smelters, iron foundries, brass foundries, blacksmith shops, etc. They are applicable to any case where a comparatively large quantity of air is required at pressures from about one to four pounds per square inch. The machines are also arranged as "exhausters" for pressures within 3.25 lbs. per sq. in. or 6.5 inches of mercury below atmospheric pressure.

These units are much simpler, more efficient, more durable and easier to operate and maintain than high pressure fan blowers or positive pressure blowers, which have hitherto been used for such service.

The units consist of a modified form of fan blower integral with the driver, which may be either an induction meter, a direct-current motor or a steam turbine. Owing to the fact that the driver and centrifugal compressor are part of the same machine, a very harmonious and compact design has been possible. Speeds, etc., have been selected to give most efficient operation as a unit and there has been no hampering from considerations of belt or gear drive, etc.

The "centrifugal compressor" is a modified type of a blower, and consists simply of an impeller rotating in a case. There is thus a maximum of simplicity. The centrifugal compressor is much more highly perfected than the ordinary fan blower, however. It successfully accomplishes results much beyond the range of the fan blower and maintains pressure vastly greater. The machines are, in fact, what are often called "turbine compressors," or "turbine blowers," and are closely related to so-called turbine pumps. The present line of machines has but a single stage. The principal feature of the compressors is the design of the passages which conduct the air to and from the impeller, leading to the flanged inlet and discharge openings. This design is such as to maintain pressures and efficiencies much greater than heretofore obtained. The impellers are also of perfected design. They are symmetrical, receiving air on both sides so as to avoid end thrust. There is ample clearance between impeller and case, so as to avoid all possibility of rubbing.

The driver is furnished as an integral part of the apparatus, so that there is no belting, gearing or other device requiring maintenance. The unit has two bearings and a single shaft on which are mounted the impeller of the centrifugal compressor and the motor of the driver. This is the only moving part.



CENTRIFUGAL AIR COMPRESSOR FOR 750 CUBIC FEET PER MINUTE, 1.7 LBS. PER SQUARE INCH AND 11-H.P. INDUCTION MOTOR.

The capacities given are based on measurements of quantity of air actually delivered under normal conditions. In comparing with positive pressure blowers, it should be noted that rated capacity for a positive pressure blower is usually the "computed displacement." The quantity of free air actually delivered is much less than the displacement of a positive pressure blower, owing to heating of air and drop of pressure while entering the machine, as well as to leakage around the moving parts. Actual tests have shown a loss of 50 per cent. or more in capacity of a positive pressure

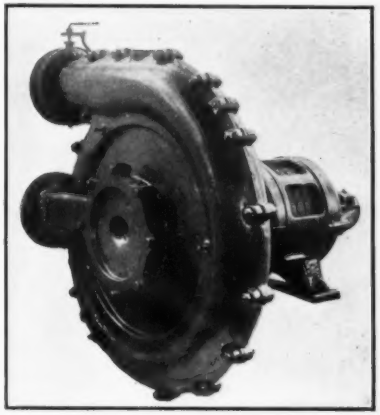
blower. In usual cases, centrifugal compressors will deliver as much air as a positive pressure blower with a rating 33 per cent greater.

All of the groups on the list are adapted for industrial air blast for various services, requiring constant pressure in the mains, whether low, moderate, or high. For this use the centrifugal compressor is vastly superior to the positive pressure blower. For such service the apparatus is arranged with a constant speed driver, either a DC shunt motor, a steam turbine or an induction motor. There is practically constant pressure independent of load, as shown by accompanying curve, and without waste of air at light loads. This is a distinct advance over positive pressure blowers, which waste air through the safety valves for all loads less than normal load and give decrease of pressure for greater loads.

The positive pressure blower, when efficiently installed, has pulleys arranged to give normal pressure when the average number of furnaces is in use and with a safety valve just on the point of blowing off. If air is not required on any of the furnaces, the normal amount of air must nevertheless be compressed to full pressure and the air not used blown off through the safety valve. If all furnaces are turned off, as occasionally occurs, the full amount of power is nevertheless absorbed and all wasted. On the other hand, if a few more than average number of furnaces are turned on, the pressure in the mains drops. Every successive addition of a furnace gives an additional drop of pressure.

This exceedingly inefficient performance is to be with the performance of the centrifugal compressor, which gives practically constant pressure, regardless of number of furnaces,—that is, of quantity of air being used. If furnaces are turned off, the quantity of air passing through the compressor automatically decreases and the power input decreases correspondingly. If no air is being used, the power input is a minimum and is only the small amount required to keep the machine rotating without load. This automatic regulation of pressure as load varies is accomplished solely by efficient design of the compressor; and no regulating devices, safety valves or other apparatus are used. At very light loads and heavy overloads, the pressure is slightly lower than normal, but for all practical purposes the variation cannot be detected at the furnaces.

As already stated, the units are remarkably simple and the only moving parts are the rotor of the driver and the impeller, which are mounted on a single shaft and run in two bearings. These bearings have the usual efficient lubrication system of the General Electric Company and seldom require renewal. There are no other parts where wear can possibly occur. The bearings are self-oiling, so that the only attention which the machine requires is renewal of the oil in the reservoirs at intervals.



CENTRIFUGAL AIR COMPRESSOR FOR 1,200 CUBIC FEET PER MINUTE, 2.7 LBS. PER SQUARE INCH, AND 30-H.P. INDUCTION MOTOR.

There are none of the belts, gears, sliding parts or other devices which give so much trouble in the usual type of positive pressure or fan blower.

A number of machines have been in service for long periods without renewal or adjustment of any kind and without attention except monthly renewal of oil.

These machines have replaced positive pressure blowers very successfully. They have avoided the pressure variation previously occurring as load varied, and the attention, oiling and frequent repairs previously necessary to keep the positive pressure blowers in good order, so that very enthusiastic testimonials have been received. In these installations the valve in

the discharge pipe may be opened or closed, putting on or off full factory load, without appreciable pressure variation or waste of air.

There is no possibility of wear in the centrifugal compressor, so that the efficiency and capacity always remain unaltered. Actual tests of machines after long service confirm this. In this respect, the apparatus is vastly superior to the positive pressure blower, which has various rubbing surfaces, which soon wear so as to cause serious leakage and great decrease of efficiency and capacity. As already stated, actual tests of positive pressure blowers have shown a loss of 50 per cent in capacity from measured displacement.

Jeffrey Switching Locomotive.

THE accompanying illustration shows a view of a 25-ton switching locomotive built by the Jeffrey Manufacturing Co., Columbus, Ohio, for use in handling freight cars for the Cerveceria Cuauhtenoc Brewery, of Monterey, Mex. This style locomotive takes the same electrical equipment as the mine type, the only changes being in the side and end frames and the addition of a platform and suitable cab to accommodate the conditions incident to surface work. The motors are of the water-proof steel frame type having drum wound armatures, laminated pole pieces, oil lubrication with auxiliary grease boxes and liberal wearing surfaces. These locomotives are built in sizes from 10 to 30 tons with two motors, in larger sizes with three and four motors arranged with rigid frame or with double trucks having flexible wheel base, depending entirely on the condition.

Fans for High Pressures.

ABOUT a half-century ago B. F. Sturtevant began the manufacture of labor-saving devices for the making of shoes, among them being a buffing wheel for smoothing the soles. The dust created by

25-TON JEFFREY SWITCHING LOCOMOTIVE.

this operation was so annoying that he soon devised an exhaust system for drawing it away. Since no suitable fan was to be purchased he designed and built one for the

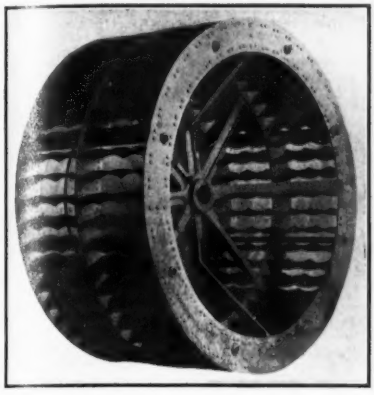


FIG. 1.

purpose. The great success of his fan system led to its use for removing refuse from wood-working machines and for the conveying of light material in a current of air. One application led to another until the fan became the vital part of systems for supplying air to cupolas, forges, etc.

At the time Mr. Sturtevant introduced his fan, the chief means of power transmission was the belt running at high speed, and naturally enough he designed his fan wheel for the pulley drive at the high rotative speeds existing in shoe factories, forge shops, planing mills, etc. At that time it was thought necessary to use small pipes and maintain the velocity created by the fan throughout the system, the conveying of air in a large pipe at low velocity not then being considered.

As shown by the accompanying illustration, Fig. 1, the wheel was made up of 24 or more blades; in other words, it was of the multivane type, and the blades were curved and of a depth equal to about one-eighth the diameter of the wheel. The wheel or runner was narrow, for the volume required was small compared with the velocity. The air, however, was drawn into the fan through two inlets giving a large area and consequently high efficiency; in fact, no more efficient fan has been designed than this type which is still being made in large quantities by the B. F. Sturtevant Company.

More extensive application of the centrifugal fan and greater knowledge of fan systems soon led Mr. Sturtevant to introduce a fan to produce large volumes. The realization that high velocities in small pipes result in considerable loss of power and pressure due to friction caused an increase in the size of the pipes or ducts. The steam engine was now direct-connected to the shaft, making the speed of the fan much lower than that heretofore used. The ventilating systems for public buildings had to be noiseless, a condition obtained only by low-speed fan. These and many other considerations necessitated wider and fewer blades, as shown in Fig. 2, which gave the larger volume at lower velocity. At the same time the proportion of blade area to volume was practically the same in the low-speed, low-pressure fan with few floats, as in the high-speed multivane fan wheel originally brought forth by Mr. Sturtevant a half-century ago.

Thus, for many years the low-pressure, low-speed, large-volume wheel of a few deep floats, either curved or flat, was also

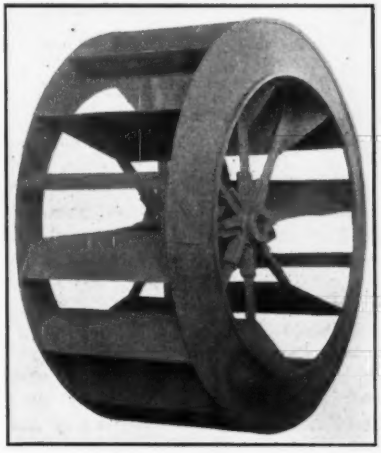


FIG. 2.

extensively applied to fan systems and such a wheel met all ordinary requirements. The actual demand in this country for a high-speed centrifugal fan for large volumes

did not assume appreciable proportions until a few years ago. The success of the steam turbine and its peculiar advantages for driving high-speed fans direct-connected has greatly increased the necessity of running them at a speed far in excess of that possible with a reciprocating engine. With the recognition of this demand came the necessity for a type of fan wheel suited to high speed and at the same time produce large volume.

Mr. Sturtevant's original multivane wheel being extensively used for small volumes, at high speed and velocity, the most natural way to obtain the large volume required was to make the blades of this high-speed wheel of greater area. To keep the proportion of blade area to volume constant and still retain the features which made the wheel of high efficiency it became necessary to make the floats shallow, the shallow floats permitting a large inlet area.

With the advent of the numerous shallow floats came other improvements. The float of Mr. Sturtevant's first high-speed wheel was straight in the direction of the shaft, although curved radially. With a narrow float as used in Mr. Sturtevant's first fan this form is entirely satisfactory, but with greater width it is not so desirable. The air entering the inlet has a tendency to slip along the straight float to the portion farthest from the inlet, thus causing that part of the wheel to handle such a large proportion of the air that it loses efficiency because of eddies, etc. Again the long straight float does not get the necessary grip on the air.

Taking lessons from every-day things, the float for the high-speed, large-volume wheel or runner is made with several cup-shaped cavities or spoons, as shown in Fig. 3. In swimming, the hand is made cup-shaped to prevent slipping. Oars for the greatest speed are always spooned to get a grip on the water. Similarly the floats of the recently-developed high-speed wheel have numerous cavities of a spherical shape so that air entering the pockets is prevented from slipping along the length of the float.

It is apparent from the foregoing that the latest development of multivane fan wheels is based upon the same principles that governed the design of Mr. Sturtevant's multivane runner of a half-century ago. The multivane wheel for large volumes at high velocities, as now built by the B. F. Sturtevant Company, is simply his wheel with wider floats made shallow to retain the large inlet area and spooned or cup-shaped to more efficiently handle the air. As his was the most efficient wheel for

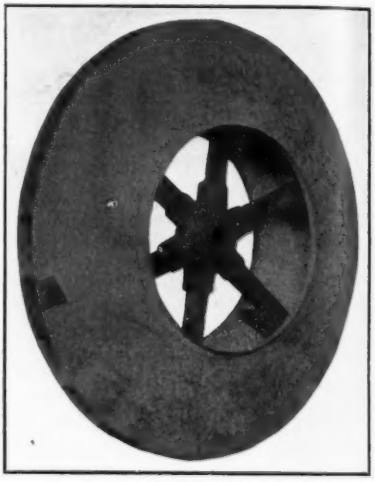


FIG. 3.

small volumes at high speed so the long-blade multivane runner is most efficient for large volumes, at the high speeds of modern turbines and electric motors.

B. F. Sturtevant Co., Hyde Park, Mass., will be pleased to furnish further particulars to interested parties.

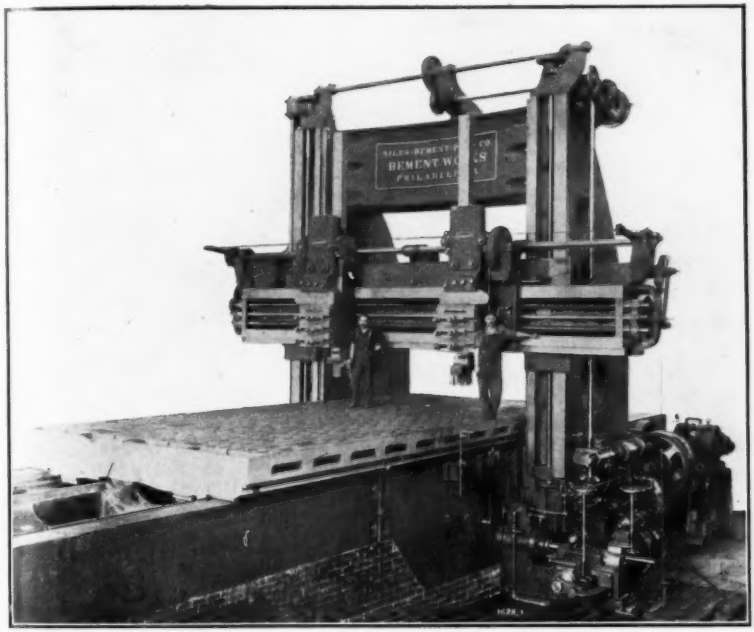
A Gigantic Planer.

PROBABLY the largest and heaviest metal working planer ever built has recently been shipped from the Bement-Miles Works (Philadelphia) of the Miles-Bement-Pond Co. The total weight of the machine is 845,000 lbs. or 422½ tons. Four motors with a total capacity of 207½ H.P. are required to operate this tool. Each head is fitted with a slotter bar independently driven by rack, giving a cutting speed that is practically constant from one end of the stroke to the other, and a quick return. Through motor and change gears,

the cutting and return speeds can be changed as desired.

Each head is arranged for transverse planing, having a planing movement across the bed which can be varied within desired limits, and having a quick return.

The movements for slotting and transverse planing make it necessary to throw out the regular driving mechanism to the table and connect it to a separate feed motion, which, in this case, is entirely distinct from the regular feed motion. This



throwing out of the driving mechanism, however, means simply that the pneumatic driving clutches are thrown into and left in their idle position.

The machine is fitted with its own air compressor and motor, thus making it independent of the air supply in the shop, to which, however, it can be connected if it seems desirable.

A complete switchboard is furnished for control of all the motors.

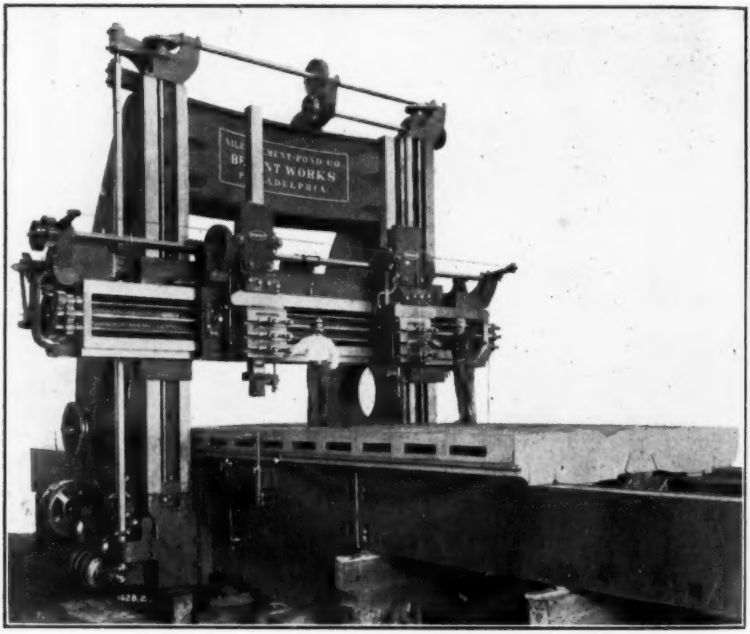
The distance between uprights is 14 ft. 4 in.; the maximum distance from table to bottom of cross slide is 12 ft. 2 in.; maximum stroke of table is 30 ft.; maximum stroke of slotter bar is 8 ft.; total width of bed, 13 ft.; length of bed, 60 ft.; table ways, 15 in. each in width; tool slides 7 ft. 8 in. with 4 ft. vertical traverse; cross rail is long enough to admit full traverse of either head between the posts; face of uprights, 2 ft. 6 in.; vertical height of cross slide, including the top rib bracing, is 5 ft.

The main driving motor is 100 H.P.; slotting and cross planing motor is 50 H.P.; lifting motor to cross slide, 20 H.P.; traverse motor for heads on cross slide, 7½ H.P.; air compressor motor, 30 H.P.

The cutting and return speeds are variable through the motor, which has a 1 to 1¼ variation and further range by change gears. The cutting speeds are 14 ft. to 25 ft. and return speeds, 52½ to 65½ ft. The same style of drive is used for the slotter, and gives a cutting speed of 18½ ft. to 30 ft. and return speed of 57 ft. to 71 ft. Cutting speed for cross planer is 11½ to 19 ft. and return speed, 35 ft. to 43½ ft. The cross traverse speed to the heads is 50 in. per minute; the vertical speed for raising

and lowering cross slide is 26 in. per minute.

The main drive from the 100 H.P. motor is clearly shown in the cut, being through the gearing shown, to the pneumatic reversing clutches at the base of the upright. The speed of these clutches can be varied to some extent, as stated above, by changing the speed of the motor and a great variation obtained by the simple reversal of two change gears. The pneumatic clutches, which are shown thoroughly incased, are of the well-known N-E-P type, with a large number of friction discs, whereby great friction area is obtained in a comparatively small compass. These clutches, as their name implies, are operated by compressed air. A small valve, easily moved by hand controls the stopping, starting and reversal of table and handles satisfactorily the power given out by the large driving motor. In the handling of this amount of power in a motor driven planer, it is unnecessary to state that it would be quite impracticable if a belt drive was employed. From this point on to the rack the drive is, in practically every respect, that which is found on any planer, except, of course, in this instance it is exceptionally heavy and powerful.



A New Recording Milli-Volt Meter and Shunt Ammeter.

ELECTRICAL engineers have long felt the need for an accurate and sensitive recording milli-volt meter adapted for laboratory tests as well as for every day practical service. There has also been a demand for a recording ammeter of the shunt type which can be connected by small leads to the main bus-bar. This shunt system is especially economical where heavy currents are to be indicated or recorded as the instruments may be located at a considerable distance from the main current, thus saving great expense in carrying the main conductors to the point where the instrument is located.

The instruments illustrated herewith have been designed to meet this particular demand. In both, the operating movement is one of special design made for this

particular purpose by the Weston Electrical Instrument Co. As a milli-volt meter, the instrument has already proven its practical value in connection with making electrolysis surveys in underground structures, being employed by the Electrical Testing Laboratories of New York for this class of work. The instrument is made so that the indicating arm will move over the whole scale for about three and one-half millivolts, making it possible to accurately record one ten-thousandth of one volt. A

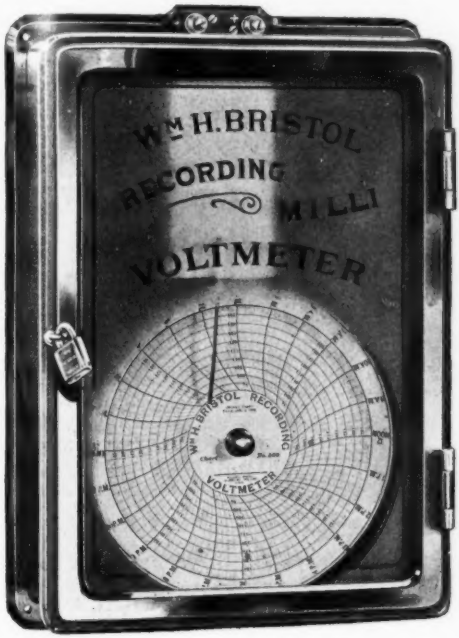


FIG. 1.

patented smoked chart is used for making the record, which is so arranged that there is absolutely no friction between the moving arm and the chart. The chart is brought periodically into momentary contact with the end of the pen arm which removes the smoke from the surface of the chart, leaving a white dot. The rate of vibration of the chart is timed to suit the frequency and range in the variation of the current to be recorded. The usual period of vibration of the chart is once in ten seconds, but to obtain continuous lines where the fluctuations of the current are quite rapid, the vibrating attachment is made to operate twice in one second. In Fig. 1 an external view of the milli-volt meter is shown.

The recording ammeter is shown in Fig. 2, as connected to a ten thousand ampere shunt of the standard Weston type. Together with the shunt is shown a Weston station ammeter. By this illustration it is clearly shown that the recorder may be readily applied to any standard shunt which is already in service, without in any way disturbing the indicating instrument at the switchboard.

It will also be apparent that the recorder could be readily furnished with almost any length of leads from the shunt on the main busbar, and also that the complete outfit, indicating instrument and recorder could be supplied as a unit with the leads of the proper lengths suited to individual cases so that the indicating instrument would be at the switchboard, convenient for the observation of the operator and the recorder located at almost any distance in the superintendent's office.

One of the features of the recorder is that the graduations on the chart are almost evenly proportioned over the entire range, the same as on the Weston ammeter, so that even though there is only a small current flowing, the readings will be as easily taken as if the current was the maximum that the instrument would record. This feature will be greatly appreciated, as there are many places where it is desirable to install instruments for increasing future demands and it is important that the records be perfectly clear even though the loads are very light when the outfit is first installed.

As a recording ammeter the instrument has been successfully applied to making continuous records of rapidly fluctuating currents such as occur in municipal trolley systems. For this class of records the clock is made to revolve once in one hour

and the vibrating attachment twice in one second.

These instruments are made by William H. Bristol, 45 Vesey Street, New York, who will furnish fuller information regarding them and their use to any one who is interested.

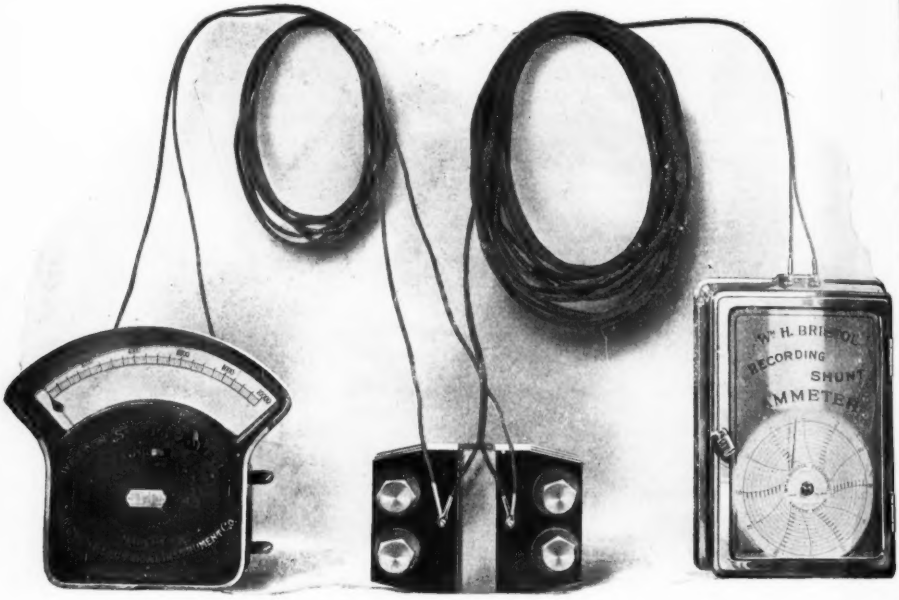


FIG. 2.

NEWS SUPPLEMENT

The Engineering Magazine—January, 1908

Personals.

—Charles P. Matthews, Professor of Electrical Engineering at Purdue University, died at Phoenix, Arizona, on Saturday November 23, 1907.

—Eugene G. Herndon, of The Dodge Coal Storage Co., Philadelphia, has been appointed resident engineer for the company at Chicago.

—J. P. Jackson, Professor of Electrical Engineering at the Pennsylvania State College, has recently been appointed by the Board of Trustees of that institution to the position of Dean of the School of Engineering.

—William S. Love, who for the past eight years managed the business of the Wheeler Condenser & Engineering Co., in the Central West, and who has been in New York for the last year as general sales manager, will resume charge of the Chicago office of the company at the Monadnock Building, on January 1st, 1908.

—R. O. Jones has assumed the duties of chief engineer of the Dayton Hydraulic Machinery Co., Dayton. Mr. Jones has had a wide experience in the manufacture and construction of pumps of all kinds, having been for the past nine years associated with the Jeanesville Iron Works, Hazelton, Pa., and for several years past was their chief engineer.

Industrial Notes.

—Among recent sales of cast iron helico-centrifugal exhaust heads, the Ohio Blower Co., Cleveland, report the following: 1-22 in. for The Big Four R. R. Co.'s new shop at Indianapolis, 1-7 in. for the Eagle

Cotton Oil Co., Meridian, Miss., 1-6 in. for the Union Mill, Fall River, Mass., and 1-6 in. and 1-16 in. for the Corn Exchange Bank, Chicago.

—The Curtis & Curtis Co., Bridgeport, Conn., have just completed a large addition to their works which gives them much larger facilities than they have heretofore enjoyed. By raising the roof of one of their main buildings they have been able to add more than 8,000 sq. ft. to their machine shop and office buildings.

—In 1900 the Tonawanda Iron & Steel Co., North Tonawanda, N. Y., installed a 4,000-h.p. We-Fu-Go water softening and purifying system. They have just placed a second order with William B. Scaife & Sons Co., Pittsburg, for an addition to their present system, to take care of increased boiler capacity of 4,000-h.p., making a total of 8,000-h.p.

—A combined heating and ventilating system of particular interest has just been installed by the Massachusetts Fan Co., Watertown, Mass., in the building recently occupied by the well-known engineering firm of Stone & Webster, Boston. Upon the same shaft are mounted two fans, one serving to draw the air through the heater and force it throughout the rooms; the other acting to exhaust foul air and discharge it above the roof. The arrangement provides for the driving of both fans by a direct connected motor placed between them.

—The Harrison Safety Boiler Works, 3138 North Seventeenth Street, Philadelphia, is sending out a quite unusual mail folder on "The Utilization of Exhaust Steam in Wood Working Establishments." With the exception of what is said about the use of exhaust steam in dry kilns and for steaming lumber, the points brought out apply to most steam plants, covering the use of the Cochrane open feed water heaters and the hot process system of water purification for keeping hard scale out of boilers, increasing the capacity of the boilers, and saving coal and boiler feed water. The folder shows an interesting layout for engine, heater, drying and heating coils and connections.

NEW CATALOGUES AND TRADE PUBLICATIONS

NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page 11.*

Air Lift System.

HUDSON ENGINEERING & CONTRACTING CO., 90 West St., New York.—Bulletin No. 51 contains an illustrated description of the Bacon patent air lift system for pumping water from underground and surface sources. 6 by 9 in.; pp. 26.

Channel Bar Piling.

NATIONAL INTERLOCKING STEEL SHEETING CO., 70 Washington St., Chicago.—Catalogue No. 2 is devoted to an illustrated description of channel bar piling. 4 by 9 in.; pp. 12.

Electric Locomotives.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Bulletin No. 4537 illustrates and describes many representative types of electric locomotives. Sketches are given of locomotives ranging from 17 to 150 tons for all classes of service. Electrical and mechanical data are given and characteristic curves for each locomotive shown. Bulletins Nos. 4542 and 4545 treat of concentric and inverted diffusers and single-phase motors respectively.

Leadite.

LEADITE CO. OF AMERICA, 1215 Filbert St., Philadelphia.—Booklet describing a composition known as Leadite for jointing water mains, etc., that requires no caulking. 5 by 7 in.; pp. 24.

Portland Cement.

LAWRENCE CEMENT CO., 1 Broadway, New York.—Well printed booklet containing illustrations of numerous buildings on which this cement has been used, together with testimonial letters. Also contains the results of laboratory tests and directions for making tests. 5¼ by 8 in.; pp. 126.

Pulleys.

AMERICAN PULLEY CO., 29th and Bristol Sts., Philadelphia.—Well-printed booklet illustrating and describing steel belt pulleys. Also contains a price list. 5¼ by 7¼ in.; pp. 38.

Pulverizer Mill.

LEHIGH CAR, WHEEL & AXLE WORKS, Fullerton, Pa.—Well-printed and handsomely illustrated catalogue describing the Fuller-Lehigh pulverizer mill. Also contains views showing many recent installations. 9 by 12 in.; pp. 46.

Reinforced Concrete.

ATLAS PORTLAND CEMENT CO., 30 Broad St., New York.—"Reinforced Concrete in Factory Construction" is the title of a book containing several chapters on concrete, concrete aggregates, methods and materials for reinforcing. Also contains ten chapters giving detailed descriptions of ten concrete factories and warehouses erected in

various parts of the country by different systems with photographs, sectional drawings and specifications. 6¼ by 9 in.; pp. 250.

Rock Drills.

SULLIVAN MACHINERY Co., Railway Exchange Bldg., Chicago.—Catalogue No. 60, second edition, describes rock drills and their advantages and illustrates their use in excavating rock under various conditions and for different purposes. 6 by 9 in.; pp. 80.

Steel Reinforcement.

GOFF, HORNER & Co., LTD., Frick Bldg., Pittsburg.—Booklet illustrating and describing the Cummings system of steel reinforcement for concrete structures. 6 by 3½ in.; pp. 16.

Strap Batteries.

WESTINGHOUSE MACHINE Co., Pittsburg.—Well-printed catalogue devoted to illustrating and describing storage batteries for portable use exclusively. Also gives prices. 6 by 9 in.; pp. 32.

Turbine Pumps.

TACONY IRON Co., Land Title Bldg., Philadelphia.—Catalogue No. 3 is devoted to an illustrated description of turbine pumps. 6 by 9 in.; pp. 32.

Valves.

KENNEDY VALVE MFG. Co., 57 Beekman St., New York.—Illustrated catalogue and price list describing valves, hydrants, etc. 9 by 5½ in.; pp. 132.

Water Gauges.

ASHCROFT MANUFACTURING Co., 85 Liberty St., New York.—Pamphlet illustrating and describing prismatic water gauges and fittings for locomotive, marine and stationary boilers. 6 by 9 in.; pp. 8.

Water-Tube Boilers.

BIGELOW Co., New Haven, Conn.—Catalogue containing a brief illustrated description of the Bigelow-Hornsby water-tube boilers. 9½ by 12½ in.; pp. 20.

OSWEGO BOILER & ENGINE Co., Oswego, N. Y. —Bulletin No. 12 is devoted exclusively to an illustrated description of the Oswego-McNaull water tube boilers. 9 by 6 in.; pp. 24.

CLASSIFIED ADVERTISING SECTION

Rate, three cents a word per month. Minimum charge $1.00 per month. No electrotypes or illustrations; no display type. Cash with order. Forms close 20th of the month preceding date of issue.

Box numbers may be used and we will forward all replies. We will not give information about any advertiser using a box number. Correspondents answering advertisements may specify that their replies shall not be forwarded to certain persons or firms—thus avoiding possible embarrassment. Original letters of reference, etc., should not be sent to unknown correspondents; copies will serve the same purpose.

HELP WANTED

DRAFTSMEN: Highest possible salaries for men experienced in any lines of drafting. List of openings free if you call or write us to-day, stating age, experience, salary and position desired. Offices in 12 cities. Confidential service for men at present employed. HAPGOODS, 305 Broadway, New York. 12-6

WANTED—A Machinery Manufacturing company wants to engage a competent man familiar with Machine Shop, Foundry and Blacksmith work; with experience in modern tool practice, to take charge of Works as Manager. Must have had experience as General Foreman or Shop Superintendent. Apply BOX 108, care THE ENGINEERING MAGAZINE, 140 Nassau St., New York, giving experience, references and age. All communications confidential. 1-1

AN OPENING for Superintendent of old established manufacturing plant, within easy reach of New York City. Applicant should have experience in designing and operating equipment to produce interchangeable parts within close limits and on a manufacturing scale. Must have had successful experience in management of works and workmen. Address, P. O. BOX 940, New York City. 1-1

AUTOMOBILES

"SUCCESS" AUTOMOBILE $250. The original motor-buggy. After eleven years labor by an engineer a perfect steel tired Auto. Runs 25 miles an hour, good hill climber. Write for particulars. SUCCESS AUTO-BUGGY MFG. CO., Inc., 532 De Baliviere Avenue, St. Louis, Mo. 12-6

BOOKS.

THE FACTORY MANAGER tells how to eliminate dead expense; unnecessary fixed charges; friction and delays; useless men, methods and records; unnecessary time and material; interruptions, "waits," and guess-work; too many handlings of work, etc., and how to arrive at exact cost of work done. Send for circular. THE ENGINEERING MAGAZINE, 140-142 Nassau Street, New York.

EVERY PRACTICAL ENGINEER should compile his own note book. Subscribe for Webber's tables, printed on 4x7" sheets, for insert binders. Every engineering subject, 25 cts. per sheet, printed both sides. Write for information to WILLIAM O. WEBBER, Consulting Engineer, 432 Exchange Building, Boston, Mass. 6-2

THE ENGINEERING INDEX ANNUAL for 1906 embraces all branches of engineering, and clearly indexes alphabetically by subject about 7,000 important articles of permanent value which appeared during 1906 in about 250 engineering journals, transactions and proceedings. Complete in itself for the period covered. We undertake to supply the full text of every article indexed in the original language, together with all accompanying illustrations. 416 pages, 9¼ by 7 inches, cloth binding; $2.00 prepaid. Sent on approval. THE ENGINEERING MAGAZINE, 140-142 Nassau Street, New York.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Tungsten Series Incandescent Lamps.

THE city of Grosse Point, Mich., has recently installed a series tungsten incandescent street lighting system where the advantages of this kind of lighting are well exemplified. The station equipment consists of two 8.8 kw. 5½ ampere constant current transformers. One of these is held in reserve, while the other supplies current to seventy-seven 60 c.p. General Electric tungsten series incandescent lamps, suspended from artistic iron poles. All wiring is laid in conduits to the poles and wires pass up the center of the pole to the lamps. The form of poles not only gives a very substantial line construction, but makes a much more artistic appearance than the usual wooden pole. These poles and lamps are shown in Figs. 1 and 2.

FIG. 1.

FIG. 2.

One of the interesting features of this system is the radial reflector with which the lamps are equipped. This form of reflector, which was recently developed by the General Electric Company, is so constructed that the light is spread and projected very evenly over considerable area instead of being nearly all concentrated in a circle around the lamp. Fig. 3 shows one of these reflectors on a lamp. It may be seen from the diagram of the candle power distribution that at about 30 degrees below horizontal the effective illumination is 50 candle power, making the efficiency at this point about 1 watt per candle power.

The series sockets with which these lamps are provided are so constructed that when a lamp is removed from the socket two contact plates of large area close together before the lamp is quite drawn out of the socket, leaving no danger of an open circuit at any time.

Tungsten series lamps are made in 32, 40 and 60 c.p. sizes, with current ratings of 4, 5.5, 6.6, and 7.5 amperes, and are ex-

ceedingly hardy on account of the heavy short filament. They will burn for nearly 1,000 hours at efficiency of from 1¼ to 1½ watts per candle power.

Another installation of series tungsten lamps for street lighting has recently been made in Grand Rapids, Mich. The lamps

FIG. 3.

are of 60 c.p. and were placed on one of the principal streets of the city. Judging from the complimentary remarks of the press and the city council, the test installation has proved highly satisfactory.

The tungsten lamp with its high efficiency should greatly increase the use of series incandescent lights in suburban and residential districts where the thick foliage makes it necessary to have the units distributed at short intervals to produce satisfactory illumination.

Hoskins Heat Gauge.

THE illustration herewith shows a new heat gauge or electric pyrometer that is a reliable and substantial instrument for shop use. This device is the outcome of some years spent in research work, in high melting point alloys that were also sufficiently high in electromotive force to produce a thermo couple that could be used with the more robust portable millivolt meter, instead of the usual delicate galvonometer. It is now possible to produce a reliable heat gauge to measure the usual industrial furnace temperature, at a cost that will enable the smallest shop to avail themselves of this great aid to accuracy.

On account of the large diameter of the series of the wires and the metals of which it is made this thermo couple or hot end needs no protecting tube, thus doing away with the use of expensive and fragile porcelain tubes. It is not affected by furnace gases and does not alloy with the non-ferrous metals, such as aluminum and its alloys, brass, zinc, copper, lead, etc. These valuable properties make it safe to use in the foundry, and will enable the founders

HOSKINS HEAT GAUGE.

to repeat with certainty the pouring temperatures that have been found to be best for strength, and to make sound castings.

In the machine shop it is usual for each tool maker to harden his own work, and because he is called on to do this only when each job is finished, he has to depend on his judgment for the proper temperature and try to remember about how hot he heated the last job. The use of a heat gauge eliminates all this guess work, and saves many times its cost in a very short time.

A prominent automobile manufacturer says that before he had a heat gauge he employed the highest paid man in his shop to do the hardening; but now he gets better results with the lowest paid man in the shop, who is simply told to keep his furnace at 750° C, or such other temperature as the work demands.

The Hoskins thermo couple or hot end has more than four times the electromotive force of the platinum-rhodium couple, giving 40 millivolts at 1000° C., as against 9 millivolts for the platinum-rhodium couple. Bureau of Standards tests show a breakdown point at 1450° C. It is guaranteed to be accurate and durable at 1200° C. and may be used occasionally as high as 1400° C. or 2550° F. Special scales are made for intermediate temperatures. The standard instruments are furnished with the Fahrenheit or Centigrade scales, reading from 400° F. to 2550° F., or 200° C. to 1400° C. The Hoskins Company, 93 Erie Street, Chicago, will gladly send a catalogue showing the Bureau of Standards tests with complete information and prices.

Argument for the Open Heater.

HOW to obtain more hot water from a boiler feed-water heater where the quantity of exhaust is limited, is discussed in a circular entitled, "May We Inquire," which is being distributed by the Harrison Safety Boiler Works, 3138 North 17th Street, Philadelphia. It shows that open heaters have the advantage over closed heaters in this respect and that they further save the condensed exhaust. The increased temperature of the feed-water from an open heater where the supply of exhaust steam is limited is represented by the following expression:

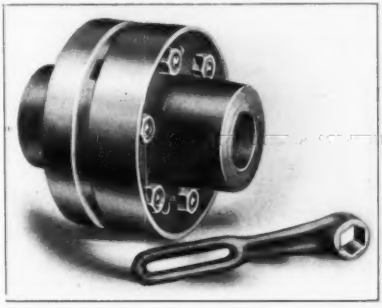
$$H \frac{p^2}{1 + p}$$

where H = the heat in a pound of exhaust steam the initial temperature of the feed-water, and p = the percentage of exhaust, as compared with the total output of steam from the boilers.

Reference is also made to the fact that the closed heater does not provide for the purification of the water, nor for the liberation of air and carbonic acid gas, as does an open heater; further, that the closed heater cannot serve as an independent oil separator, expansion and return tank, pump governor, hot well, etc., as can a Cochrane Heater. It is further claimed that an open heater is much more easily cleaned than is a closed heater, this point being illustrated by some interesting photographs.

The Hendershot Coupling.

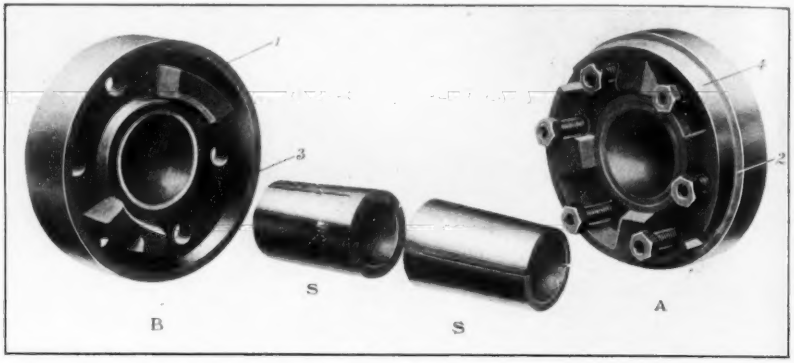
A NEW shaft coupling to be known as the Hendershot coupling is being placed upon the market by Manning, Maxwell & Moore, Inc., of 85 Liberty Street, New York. It possesses several new features which give it great strength and facilitate its quick and convenient application. It will be noted that two short taper compression sleeves are provided, which make it possible to put the two halves of the coupling in place while the shafting is upon the floor, so that it may be hoisted into



THE HENDERSHOT COUPLING SHOWING ITS GENERAL APPEARANCE ASSEMBLED.

position and bolted together as easily as the old-fashioned plain flanged coupling.

The shells contain cast lugs which, interlocked, form a clutch, thereby taking the strains upon the shells themselves. This relieves the bolts of all shearing strains and makes a most rigid and durable connection. Although the bolts are relieved of shearing strains, about 50 per cent. more of them than usual are used. This is in keeping with the very large compression area of this style of coupling and the unusually large factor of safety provided.



THE HENDERSHOT COUPLING SHOWING PARTS UNASSEMBLED.

In applying the coupling the shells are slipped upon the shafting first. Then the sleeves are put into place so that the shells may be drawn over them. The lugs of shells are brought into interlocking position and the shells are bolted together.

The coupling is easily taken apart by screwing two bolts in holes that are tapped in the shell for the purpose. In coupling shafting together this construction permits of a great saving in time, especially in a new factory where it is not convenient to start up to see how the line runs. This feature will meet with the approval of millwrights and mechanics who have had experience in coupling shafting with compression couplings of the single sleeve type. It should also appeal to mill owners, as the time saved in using the Hendershot coupling is quite an item. If put on properly the shafting cannot be sprung.

If the shafts to be coupled vary a little in size, are a little out of line, or both, the Hendershot coupling will adjust itself and the compression will be the same the full length of the sleeve, which is not possible with the sleeve in one piece. The sleeves are made thinner and the hubs heavier, thereby greatly increasing the strength without increasing the outside diameter of the coupling. The coupling is made of the best gray iron, and is heavy enough to withstand all strains. Every coupling is put together on a test pin and inspected before it leaves the factory.

Jeffrey Freight Handling Machinery.

ALL steamboat cargo discharged or awaiting shipment at the Virginia street dock in Seattle is stored in a warehouse on the opposite side of Railway avenue, distant about 250 feet from the dock. To transfer the large volume of miscellaneous freight handled daily between the dock and warehouse, both economically and at the necessary speed without obstructing traffic in the street, the company has recently installed an over-head carrier which performs the work at a cost which is hardly appreciable and which is capable of handling the freight more rapidly than it is possible to load or dispose of it at the terminal points. As the equipment is very simple and can be modified to suit practically any industrial condition which involves the movement of packages or miscellaneous articles in large numbers between fixed points, a brief description will

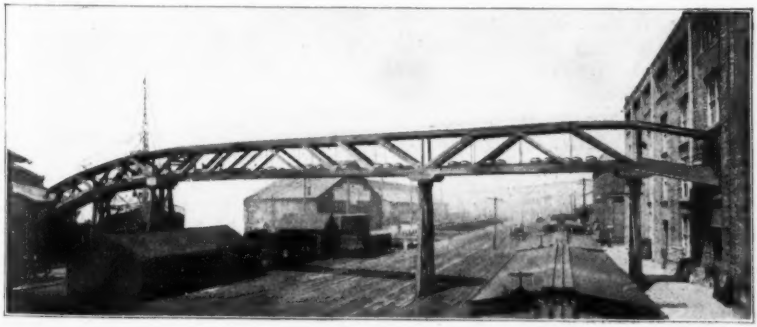
be of general interest. As shown by the accompanying illustrations, the dock and warehouse are connected by a light elevated structure which supports a continuously moving carrier of the endless chain type, with terminals on the dock level at one end and on the second floor of the warehouse at the other.

CARRIER AT DOCK END.

The carrier consists of a series of wooden flights, 9 inches wide by 4 inches thick and 30 inches long, made of Puget Sound fir. These are secured every 12 inches to two strands of No. 80 Jeffrey steel thimble roller chain, forming a practically continuous apron on which the freight is carried. Wedge shaped blocks attached to every third flight serve to push or retard such freight as might otherwise roll down the incline at the dock end.

The machinery is driven at the upper or warehouse end by a 10 h.p. electric motor, and being reversible it carries the freight to equal advantage in either direction. It is designed to handle packages not exceeding 3 feet wide and 4 feet high, which normally consist of salmon in cases, sacks of salt and sugar, barrels of cement, and miscellaneous articles weighing as much as 1,000 lbs. each.

It travels at a speed of 70 feet per minute and consumes about 6 h.p. when delivering 1,000 packages weighing 100 lbs. each, per hour. This rate of delivery is based on the speed at which the packages can be loaded and cared for at the terminal points, and is much below the actual capacity of the machine.



DOCK—RAILWAY AVENUE—WAREHOUSE.

The plant was designed and installed by the Pacific Engineering Company of Seattle, Wash., the conveying machinery being furnished by the Jeffrey Manufacturing Company of Columbus, Ohio.

The Central Power Station at the Plant of Walter Baker & Co., Ltd.

THE establishment of Walter Baker & Co., Ltd., at Dorchester, Mass., embraces a number of mills engaged in the manufacture of chocolate and cocoa products. They are located at the crossing of Washington street and the Neponset River, about six miles from the center of Boston, and embrace plants on opposite corners of the street and the stream, known as the Baker mill, the Webb mill, the Pierce mill and others. These mills are large plants in themselves, which have, until recently, been operated by independent steam plants. In each case the engines were pairs of horizontal simple condensing and non-condensing engines, supplied with steam by horizontal return tubular boilers, but it was some three years ago decided to have an economical central plant. For this purpose an extensive new power station has been built for the operation of all the mills as a single unit, by means of which a maximum of economy and reliability might be attained.

The new power plant, of which the following description is furnished by Allis-Chalmers Co., through courtesy of F. W. Dean, the consulting engineer and architect, has been located apart from the mills, so as not to interfere with future extensions and additions to the mills, and so that the latter may not, in any way, be dependent upon power considerations. It is situated on the northerly bank of the Neponset River upstream from the mills, where the stream is several hundred feet in width and an ample supply of circulating water is available. The river water is of such a quality that it is used for feed for the boilers as well as for condensing. Convenient rail connections were also available at this point, for receipt of fuel and for handling machinery.

The plant is laid out on the cross-boiler room principle, with a 60 x 80 ft. main engine room and a 57 x 96 ft. boiler house extending at right angles from one end. It is constructed of brick on concrete foundations throughout, and has a wooden roof supported on steel trusses. The architectural treatment of the exterior is simple, yet productive of pleasing results, a feature of which is the liberal provision of windows for interior lighting. The roofs are covered with tarred paper and gravel and are nearly flat, draining to the outside with inside gutters. The interior is finished with common red brick painted with cold water paint in the boiler room, while in the engine room the finish is red pressed brick with limestone trimmings, by means of which an attractive interior has been secured. In the latter room the roof planking is concealed by sheathing of matched North Carolina pine. For the handling of machinery a 10-ton hand-operated traveling crane of 59-ft. span covers the engine room, traveling on 20-in. I-beam runways, which are supported upon ornamental pilasters in the wall construction at frequent intervals.

The plant has been designed for an ultimate capacity of 2,800 H.-P. in boilers, and 1,750 K. W. in electrical generating machinery.

The two large units are vertical cross-compound engines built by the Allis-Chalmers Co., which have 22 and 48-in. cylinders with 48-in. stroke. They are both direct-connected to 750 K. W. alternating current Allis-Chalmers generators, which are mounted alongside of the 15-ft. flywheels on the engine shafts. The smaller generating units consist of simple horizontal 18 x 26-in. engines, direct-connected to Allis-Chalmers 125 K. W. alternators. There are, in addition to the above, two steam turbine generator sets of 50 K. W. capacity each, which, together with a motor-generator set of equal capacity, are utilized for excitation purposes. The large engine units are supplied with steam by 8-in. connections from the boiler room main, while the small horizontal units have 5-in. connections and the turbines 3-in. connections from the basement steam main. The larger units exhaust, as above stated, to the condensing units in the basement and the small engines to the low-pressure main in the basement. A noteworthy feature of the

engine installation is the use of reheaters for compound engines, which are supplied with heat by the hot gases passing from the boilers to the stack. These reheaters consist of large cylindrical receivers, each fitted with a large number of 6-in. boiler tubes through which the hot gases are passed. They are located, as previously stated, on the concrete platform in the boiler room, elevated 13 ft. above the floor to facilitate connections to the flues and economizer. The smoke connections are led to both reheaters in multiple, while the steam connections are separate, one reheater serving for either engine. The latter connections consist of 10-in. lines from the exhaust side of the high-pressure cylinders, and 18-in. return lines from the reheaters to the admission side of the low-pressure cylinders, the steam being superheated about 30° Fahr. in passing through the reheaters under ordinary conditions. The oiling of the compound engines is accomplished by gravity from an elevated tank, the oil after passing the engines flowing by gravity to a filter in the basement, from which it is returned to the elevated tank again by a small duplex pump.

The boiler feeding equipment consists of two duplex outside end packed feed pumps, a Cochrane feed-water heater and purifier and a Sturtevant economizer, all of which have been installed of sufficient capacity provided for the total projected boiler plant of 14 boilers. The pump and the heater are located in the space underneath the elevated platform carrying the hot gas reheaters, and the economizer in the side addition to the boiler room, in which it is mounted on a concrete platform 8 ft. above the floor level and is 44 ft. in length. The feed pump suction connections are so arranged that the pumps will ordinarily draw through 6-in. suctions from the feed-water heater into which the condensation from the surface condensers is delivered by condensation pumps in the engine room basement.

The Allis-Chalmers generators deliver three-phase, alternating current at a potential of 600 volts, at which voltage current is transmitted directly to the mills for power and lighting purposes. The power feeders and the machines are controlled from a blue Vermont marble switchboard 60 ft. in length, which contains panels for the generators and feeders, and totalizing instrument panels. All circuits to the different mills have recording meters for measurement of the power supply to each department separately. The mills are operated entirely by induction motors, of which there are about 100 installed, ranging from 1 to 75 H.P. and arranged for both individual and group driving. The lighting is done on the two-wire system at 110 volts, the voltage being reduced from the power feeder lines by transformers at each mill. The power feeders are carried to the mills through a steel bridge to the Baker mill, from which they pass over a bridge across the river to the Webb mill and through a subway some 200 ft. in length under Washington Street to the Pierce and other mills.

This power plant and the new power and lighting equipment of the various mills was designed and the construction superintended by Mr. F. W. Dean, mill engineer and architect, of Boston, Mass., formerly of the firm of Dean & Main.

"A Brief About Hot Water" is the title of a folder being distributed by the Harrison Safety Boiler Works, No. 3138 North 17th Street, Philadelphia. The reading matter relates particularly to the uses of hot water in textile establishments, pointing out that water for dye tubs, washing and scouring, boiler feeding, etc., can be heated much more economically by means of exhaust steam than with live steam or by direct application of fire. The Cochrane Open Feed Water Heater not only supplies hot water for these purposes, but also takes the place of a return tank, expansion or muffle tank, oil separator, steam trap, hot well, etc., making it possible, without the purchase of further apparatus, to utilize exhaust steam for heating and drying and to conserve all condensed returns.

NEWS SUPPLEMENT

Personal.

—Henry H. Cypher has severed his connection with the Eureka Fire Hose Co., New York.

—Walter B. Snow, Boston, has been elected president of the Alumni Association of the Massachusetts Institute of Technology.

—T. Vaughn Stapler, formerly advertising manager of the American Sheet & Tin Plate Co., announces his connection with Hill & Stocking, advertising agents, Commonwealth Trust Building, Pittsburg.

Theodore L. Webster, secretary of Warren Webster & Co., was killed in the crash of railroad trains at Camden, N. J., on December 19. He had been connected with the company since its establishment, twenty years ago.

—Myron H. Lewis and Clifford B. Moore, editors of "Waterproofing," have opened offices in the St. James Building, 1133 Broadway, New York, where they will conduct a general consulting engineering business in waterproofing, foundations, hydraulics and reinforced concrete.

—Professor Hugo Diemer, whose contributions to this Magazine will be remembered with pleasure by our readers, has discontinued his position with the Goodman Manufacturing Co., Chicago, where he was consulting engineer in charge of shop organization and systematizing, and has accepted the chair of mechanical engineering at the Pennsylvania State College, in charge of the Department.

Industrial Notes.

—The Bristol Co., Waterbury, Conn., has been awarded a silver medal for their recording instruments exhibited at the Jamestown Exposition.

—The Ball & Wood Co., Elizabethport, N. J., announces the addition to its engine business of a line of air compressors of new and advanced type, designed to meet the modern requirements for air compressing machinery.

—The Keuffel & Esser Co., Hoboken, N. J., have just issued their Solar Ephemeris for 1908. The information contained in this little booklet is of much value to engineers and surveyors and they will be glad to furnish it free on request.

—The Old Colony Trust Company's offices in the Ames Building, and the office building of the Thorndike Estate, both in Boston, are being equipped with fans manufactured by the Massachusetts Fan Co., Watertown, Mass. All of the fans are to be electrically driven by direct-connected motors. The heating surface for St. Agatha's School, New York City, is under contract to be furnished by the same company.

—The Ohio Blower Co., Cleveland, report recent sales of the "Swartwout" helico-centrifugal cast iron exhaust head as follows: Two each to Missouri Pacific Railroad Co., and Mississippi Cotton Oil Co., Natchez, Miss.; 1-6 in. to Municipal Light Plant, Hamilton, Ohio; 1-10 in. to Narragansett Brewing Co., Providence; 1-16 in. to Alliance Gas & Power Co.; 1-6 in. to Garfield Worsted Mills, Passaic; 1-10 in. to Union Typewriter Co., Bridgeport; 1-18 in. to Wheeling Traction Co., Wheeling; 1 to Waterbury Castings Co., Waterbury.

—The Goulds Manufacturing Co., Seneca Falls, N. Y., announce that they have recently completed their new office and factory and are now located in the same. The new office building is 73 x 73 ft., two stories high, well appointed, finely finished and furnished. The office is in close proximity with the new additions of the plant just completed and consists of a foundry 500 x 144 ft., rattling room 161 x 42 ft., pattern shop 161 x 42 ft., two stories high, two pattern storages 182 x 42 ft. each, four stories high, storage building, railroad trestle for handling coal, coke and sand, 175 x 50 ft., and a power house 65 x 127 ft.

—The General Electric Co., Schenectady, N. Y., has issued a pamphlet completely describing the electrification of the West Shore Railroad between Utica and Syracuse. The pamphlet is illustrated with

views of the trains, interior of the cars, transmission lines, exterior and interior of sub-stations, plans of the buildings and wiring diagrams, and details of the track construction. One of the most interesting features is a comparison of two train sheets, one showing the operation before electrification, and the other after, where the increase in traffic with the same track capacity is very strikingly shown.

—The general offices of the Wheeler Condenser & Engineering Co. were removed from New York to the works at Carteret, N. J., on January 1st, 1908, and all the present New York employees transferred there. The company is erecting a very extensive addition to their present office building in Carteret to accommodate the increased force and to provide room for the executive offices. The drawing-room will be enlarged and occupy practically the entire upper floor of the office building, while additional room will also be provided for the engineering department proper.

—Power Specialty Co., New York, report the following sales of Foster patent steam superheater: Alabama White Marble Co., 600 h.p. in Wickes boilers; Babcock & Wilcox Co., for Pensacola Navy Yard, 1600 h.p. in B. & W. boilers; United Shoe Machinery Co., 1032 h.p. in B. & W. boilers; Clark Thread Co., Newark, 2500 h.p. in Stirling boilers; American Railways Co., 838 h.p. in Stirling boilers; Louisville & Eastern Railroad, 600 h.p. in Heine boilers; Tonawanda Board & Paper Co., 900 h.p. in return tubular boilers; Schlitz Brewing Co., 2000 h.p. in Edge Moor boilers; Anheuser-Busch Brewing Association, 2000 h.p. in Heine boilers.

—The Bristol Co., Waterbury, Conn., are issuing three new bulletins, covering their electrical instruments: Bulletin No. 61, describing recording voltmeters, which is in 12 pages, illustrated, and is very complete; Bulletin No. 62, describing recording ammeters, lists a new form of portable instrument which is now being manufactured and is very attractive in its make-up. Bulletin No. 63 covers a line of recording wattmeters and is somewhat larger than the others, having 19 pages. This bulletin, besides illustrating the new portable form of wattmeter, also shows a very complete list of single, two-phase and balanced three-phase alternating current instruments, something that was absent from former bulletins.

—During the past few years the Ohio Blower Co., Cleveland, has been progressively introducing the helico-centrifugal type of oil and steam separator. In this appliance the steam is given a whirling motion which positively separates the oil and water from the steam through the action of centrifugal force. No obstruction is presented to direct flow. Among recent sales of various types the following are reported. Steam separators for the Hammermill Paper Co., Erie; the Phillip-Carey Mfg. Co., Lockland, O.; the Carnegie Steel Co., Duquesne Works, Pittsburg,; the General Electric Co., Fort Wayne Works, Indiana; and the Louisville Lighting Works, Louisville; also oil separators for the Carnegie Natural Gas Co., Pittsburg; Standard Welding Co., Cleveland; and the General Electric Co., Fort Wayne Wks., Ind.

—The Rail Joint Co., New York, is the exclusive maker of base supporting rail joints and is the largest producer of rail joints in the United States. During 1907 the output of the company was in excess of any previous year. All the various types manufactured by The Rail Joint Co. for standard and special rail sections, also the step or compromise and insulating rail joints, have the greatest amount of contact bearing surface and that fact eliminates the destructive features which are commonly known in weaker appliances. The application to tee and girder rails for steam and electric railroad use has become universal, as they present a higher degree of permanency than any appliance that has ever been used. In the contract of the Panama Railroad, the government engineers approved of the continuous type for their entire work, and the best engineers in the United States, also Japan and other foreign countries have done likewise. The total quantity shipped for steam and electrical railroads up to date is more than sufficient to equip a railroad that would encircle the earth.

—A. M. Morse, the Chicago representative of Harrisburg Foundry & Machine Works, Marquette Building, reports the

following recent installations of Fleming-Harrisburg self-lubricating engines in Chicago territory: Minahan Office Building Co., Green Bay, Wis., 1-400 h.p. tandem compound standard engine, and 1-250 h.p. standard; The Lake Shore Engine Works, Marquette, Mich., 1-250 h.p. standard; Fleming Office Building Co., Des Moines, Ia., 2-125 h.p. standard; Western Clock Mfg. Co., LaSalle, Ill., 1-250 h.p. four-valve; Geo. Ziegler Co., Milwaukee, 1-180 h.p. four-valve, and 1-125 h.p. standard; Chicago, Burlington & Quincy Railway Co., West Burlington, Ia., 1-300 h.p. cross compound four-valve; Armstrong Bros.' Tool Co., Chicago, 1-100 h.p. standard; Eastman Kodak Co., Chicago, 1-150 h.p. four-valve (second order); Congress Hotel Co., Chicago, 2-600 h.p. and 1-400 h.p., all of four-valve type; St. Luke's Hospital, Chicago, 2-250 h.p. standard; Morrison Hotel and Restaurant Co., Chicago, 1-250 h.p. four-valve; Vendome Hotel, Chicago, 1-100 h.p. standard.

NEW CATALOGUES AND TRADE PUBLICATIONS

NOTE.—The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page 11.

Boiler Water Purifier.

WIEMANN-MUNHALL CO., Farmers Bank Bldg., Pittsburg.—Booklet illustrating and describing boiler water purifier for preventing scale in boilers. 7 by 5 in.; pp. 16.

Cold Metal Saw.

LEA EQUIPMENT CO., 136 Liberty St., New York.—Catalogue No. 5 illustrating and describing cold metal saws for cutting metal stock, structural steel, etc. 6 by 9 in.; pp. 16.

Concentrating Machinery.

UNITED IRON WORKS CO., Springfield, Mo.—Well-printed catalogue illustrating and describing hoisters, crushers, crushing rolls, etc. 10 by 6½ in.; pp. 58.

Concentrating Table.

TRAYLOR ENGINEERING CO., 2 Rector Street, New York.—Catalogue illustrating and describing concentrating tables. Rock crushers, stamp mills, converters, copper matting blast furnaces and other mining machinery are also given a place. 7 by 10 in.; pp. 24.

Concrete Pipes.

REINFORCED CONCRETE PIPE CO., Jackson, Mich.—Catalogue illustrating and describing reinforced concrete pipe for sewers, conduits, railroad culverts and water pipe. Also contains numerous testimonial letters and views showing some of their recent work. 8 by 10½ in.; pp. 36.

Conveying Machinery.

CHAIN BELT CO., Milwaukee.—General catalogue No. 35 treats of elevating, conveying and power transmitting machinery. The catalogue is well printed and illustrated with many views showing recent installations. Also contains many tables giving much valuable data. 6 by 9 in.; pp. 288.

Cyanide Filters.

PACIFIC TANK CO., San Francisco.—Catalogue illustrating and describing cyanide tanks, mining and mill supplies. 5 by 8 in.; pp. 192.

CHALMERS & WILLIAMS, Commercial Natl. Bank Bldg., Chicago.—Catalogue No. 1, Section J, is devoted to an illustrated description of cyanide filters for filtering slimes in large quantities quickly and at a comparatively small cost. 7 by 9 in.; pp. 16.

Drawing Materials.

FREDERICK POST CO., Chicago.—Catalogue and price list of drawing materials and mathematical instruments. Illustrated. 6 by 9 in.; pp. 222.

Dredging Machinery.

NORTH AMERICAN DREDGING CO., Merchants Exchange Bldg., San Francisco.—Booklet illustrating and describing dredging machinery of all descriptions. 7 by 5 in.; pp. 32.

Electrical Dynamometers.

SPRAGUE ELECTRIC CO., 527 W. 34th St., New York.—Bulletin No. 108 treats of electric dynamometers for testing gasoline engines. 8 by 10½ in.; pp. 8. Bulletin No. 230 illustrates and describes the electric equipment of a modern factory. 8 by 10½ in.; pp. 20.

Gas Engines.

S. M. JONES CO., Toledo.—Catalogue devoted to an illustrated description of vertical gas engines. 9 by 6 in.; pp. 24.

Gasoline Engines.

HART-PARR CO., Charles City, Ia.—Catalogue treating of stationary, portable and traction oil cooled gasoline engines. 9 by 6 in.; pp. 40.

Geared Hoists.

DETROIT HOIST & MACHINE CO., Detroit.—Catalogue presenting a few designs of pneumatic geared appliances for hoisting or operating power devices. 6 by 9 in.; pp. 20.

Grinders.

SAXON MACHINE CO., Holyoke, Mass.—Four pamphlets illustrating and describing surface grinders, vertical cylinder grinders and guide bar grinders. 6 by 9 in.; pp. 4.

Grinding Wheels.

NORTON CO., Worcester.—Pamphlet illustrating and describing grinding wheels and machinery, together with tables of grinding wheel speeds and price list. 3½ by 6 in.; pp. 12.

Hydraulic Jacks.

A. L. HENDERER'S SONS, Wilmington, Del.—Catalogue illustrating and describing hydraulic jacks and boiler makers' specialties. 9 by 6 in.; pp. 42.

RICHARD DUDGEON, Broome and Columbia Streets, New York.—Well-printed catalogue describing different types of hydraulic jacks, together with tables giving sizes, weights, prices, etc. Illustrated. 6 by 9 in.; pp. 30.

Lifting Magnets.

ELECTRIC CONTROLLER & SUPPLY CO., Cleveland.—Well-printed and handsomely illustrated catalogue describing various types of lifting magnets and their uses. Also contains views showing many recent installations, together with a list of users. 8 by 10½ in.; pp. 32.

CLEVELAND ARMATURE WORKS, Cleveland.—Catalogue illustrating and describing inter-pole bell and flat magnets. The bell magnet is designed especially for handling pig iron, scrap iron and all small pieces of iron and steel, while the flat magnet is suitable for handling flat surface pieces from 1 to 12 tons. 8 by 10 in.; pp. 16.

Mechanical Coal Shovel.

SARCO FUEL SAVING & ENG'G CO., West St. Bldg., New York.—Catalogue illustrating and describing the mechanism of the Caldwell automatic mechanical coal stoker. 6 by 9 in.; pp. 16.

Metallic Packing.

H. W. JOHNS-MANVILLE CO., 100 William St., New York.—Booklet devoted to an illustrated description of Morris metallic packing for Corliss valve stems and all piston rods, steam turbines, hydraulic, air, gas, ammonia, and vacuum. 4½ by 7 in.; pp. 14.

Milling Machines.

INGERSOLL MILLING MACHINE CO., Rockford, Ill.—Catalogue No. 16 is devoted to an illustrated description of heavy milling machines exclusively. The catalogue is well printed in two colors. 6 by 9 in.; pp. 64.

Mine Cars.

HOCKENSMITH WHEEL & MINE CAR CO., Penn Station, Pa.—Catalogue devoted to an illustrated description of mine cars and wheels. 4½ by 7 in.; pp. 36.

Packing.

HENRY JOHNSON CO., Jersey City.—Catalogue printed in two colors, treating of various styles of packing. Illustrated. 4¼ by 6½ in.; pp. 92.

Pipe Threading Machinery.

BIGNALL & KEELER MFG. CO., Edwardsville, Ill.—Catalogue, cloth bound, treating of pipe threading and cutting machinery, together with tables giving prices, dimensions, etc. Illustrated. 6 by 9 in.; pp. 56.

Power Presses.

ZEH & HAHNEMANN, Newark.—Catalogue illustrating and describing power presses for working sheet metals, together with tables giving dimensions of the presses. 6 by 9 in.; pp. 36.

Pumping Machinery.

A. S. CAMERON STEAM PUMP WORKS, E. 23rd St., New York.—Well-printed catalogue illustrating and describing pumping machinery for all purposes. Also contains much useful data and statistics for pumpmen and engineers. 6 by 9 in.; pp. 158.

KNOWLES STEAM PUMP WORKS, 114 Liberty St., New York.—General catalogue K-800 is devoted to an illustrated description of pumping machinery for all services, together with tables giving dimensions, capacity, etc. 6 by 9 in.; pp. 174.

Reamers.

WM. J. SMITH CO., New Haven.—Pamphlet illustrating and describing one-lock adjustable reamers, together with price list. 6 by 9 in.; pp. 8.

Refrigerating Machinery.

TRIUMPH ICE MACHINE CO., Cincinnati.—Well printed catalogue devoted to an illustrated description of compressors, ammonia condensers, oil intercepters, ice can hoists, etc. 6 by 9 in.; pp. 64.

Road Rollers.

MONARCH ROAD ROLLER CO., Groton, N. Y.—Catalogue illustrating and describing road rollers. 9 by 6 in.; pp. 20.

Shaking Grates.

SCRANTON STEAM PUMP CO., Scranton, Pa.—Catalogue No. 11 illustrates and describes the Scranton shaking grate and Union steam blower for burning cheap fuel in boilers or other furnaces. Contains many views showing some recent installations. 9 by 6 in.; pp. 54.

Shapers.

GEO. JUENGST & SONS, Croton Falls, N. Y.—Circular briefly illustrating and describing shapers, together with table giving dimensions, weights, etc.

GOULD & EBERHARDT, Newark.—Catalogue illustrating and describing shapers made in 14, 16, 20, 24 and 34" sizes. Various attachments, as well as odd jobs that can be accomplished, are shown in the back of the book. 9 by 6 in.; pp. 52. Also a catalogue treating of automatic gear cutting machinery. 9 by 6 in.; pp. 60. Both catalogues are well printed and illustrated.

Shop Furniture.

NEW BRITAIN MACHINE CO., New Britain, Conn.—Catalogue illustrating, with brief descriptions, bench legs, tool racks, lathe pans, lathe

racks, shelving, steel racks, stools, waste cans, trucks, etc. 4 by 7½ in.; pp. 52.

Steam Appliances.

JARVIS ENGINE & MACHINE WORKS, Lansing, Mich.—Catalogue illustrating and describing water purifiers, oil extractors, safety columns, and steam pumps, together with prices, dimensions, etc. 4½ by 8 in.; pp. 32.

Steam Separators.

POWER PLANT SPECIALTY CO., 245 So. Jefferson St., Chicago.—Bulletin No. 2, contains an illustrated description of the Vater two-stage separator and receiver, horizontal form, together with a partial list of the power plants in which this separator has been installed. 7 by 10 in.; pp. 12.

Stokers.

ROSEDALE FOUNDRY & MACHINE CO., Allegheny, —Catalogue illustrating and describing chain grate stokers. 9 by 6 in.; pp. 28.

Vises.

CHARLES PARKER CO., Meriden, Conn.—Catalogue treating of vises and ratchet drills adapted to machinists, locomotive works, etc. 6 by 9 in.; pp. 64.

Water Tube Boilers.

D. D. FLANNER BOILER CO., Toledo.—Well-printed catalogue illustrating and describing Park water tube boilers. 6 by 9 in.; pp. 16.

CLASSIFIED ADVERTISING SECTION

Rate, three cents a word per month. Minimum charge $1.00 per month. No electrotypes or illustrations; no display type. Cash with order. Forms close 20th of the month preceding date of issue.

Box numbers may be used and we will forward all replies. We will not give information about any advertiser using a box number. Correspondents answering advertisements may specify that their replies shall not be forwarded to certain persons or firms—thus avoiding possible embarrassment. Original letters of reference, etc., should not be sent to unknown correspondents; copies will serve the same purpose.

HELP WANTED

SALESMEN: Technical trained men to sell machinery or kindred lines. Salary and commission; choice of desirable territory. Also good positions for Architects, Chemists, Draftsmen, Foremen, Superintendents and other high-grade technical men. HAPGOODS, 305 Broadway, N. Y. 12-6

AUTOMOBILES

"SUCCESS" AUTOMOBILE $250. The original motor-buggy. After eleven years labor by an engineer a perfect steel tired Auto. Runs 25 miles an hour, good hill climber. Write for particulars. SUCCESS AUTO-BUGGY MFG. CO., Inc., 532 De Baliviere Ave., St. Louis, Mo. 12-6

BOOKS.

THE FACTORY MANAGER tells how to eliminate dead expense; unnecessary fixed charges; friction and delays; useless men, methods and records; unnecessary time and material; interruptions, "waits," and guess-work; too many handlings of work, etc., and how to arrive at exact cost of work done. Send for circular. THE ENGINEERING MAGAZINE, 140-142 Nassau Street, New York.

EVERY PRACTICAL ENGINEER should compile his own note book. Subscribe for Webber's tables, printed on 4x7" sheets, for insert binders. Every engineering subject, 25 cts. per sheet, printed both sides. Write for information to WILLIAM O. WEBBER, Consulting Engineer, 432 Exchange Buildling, Boston, Mass. 6-2

THE ENGINEERING INDEX ANNUAL for 1906 embraces all branches of engineering, and clearly indexes alphabetically by subject about 7,000 important articles of permanent value which appeared during 1906 in about 250 engineering journals, transactions and proceedings. Complete in itself for the period covered. We undertake to supply the full text of every article indexed, in the original language, together with all accompanying illustrations. 416 pages, 9½ by 7 inches, cloth binding; $2.00 prepaid. Sent on approval. THE ENGINEERING MAGAZINE, 140-142 Nassau Street, New York.

MACHINERY FOR SALE

PEAT MACHINE — mounted on portable platform, producing 4 tons peat fuel per hour. Latest German design. Strong and durable. Simple operation. 33 feet chain elevator. For sale complete, $900. JULIUS BORDOLLO, Briquette Machinery, Kingsbridge, New York City.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

High Speed Sand Handling Plant.

THE National Equipment Co. of Chicago recently installed for the P. L. Price Sand Co. of Tulsa, Oklahoma, a model sand handling plant. The plant was designed to transfer sand from barges to railroad cars by means of a steel derrick and clam-shell grab of two cubic yards capacity. The derrick is of special construction suited to the severe strains resulting from the high speed of operation. The boom is built up of steel angles latticed in a manner to insure the greatest stiffness and durability. The other members are of the latticed channel and box girder types. The boom is swung by means of a steel bull-wheel of special construction.

There are several novel features in the design. The mast bottom or foot casting is so arranged as to run in oil, a bronze wearing plate being provided which may be easily renewed when worn out. The mast top is also provided with bronze wearing plate and gudgeon bushing, both being lubricated by a special device.

All sheaves are extra heavy and of large diameter, bronze bushed and lubricated by means of compression grease cups on center bored axles No expense was spared to make this plant the best in point of quality even down to the smallest detail. The bucket and boom fall lines are operated by a double cylinder, three friction drum hoisting engine, and the bull-wheel is turned by a patent independent steam swinging engine. These two engines are controlled by one man, the lever system being so designed that all levers are within easy reach. The steam

for these engines is furnished by a 50 horse power locomotive type fire-box boiler built especially for this plant. The boiler specifications called for a working pressure of 125 pounds.

The derrick, machinery and boiler are located on concrete foundations which were installed by the purchaser according to the design of the National Equipment Co. The constructor of the equipment company erected the plant complete, put the machinery in operation and instructed the engineer of the sand company. The capacity of the plant was estimated conservatively at 50 round trips of the bucket an hour, which for continuous operation would attain a total capacity of 1,000 cubic yards a day. The actual capacity of the plant, however, has proved to be 20 per cent. higher than the above figures. On this basis the cost of handling the sand is less than 1 cent per cubic yard.

A New Type of High Speed Steam Engine.

A NEW and interesting type of high speed engine is described in the following article for the first time in this Magazine. This engine marks a distinct epoch in the development of practical steam engines, and is the culminating work of a life time spent in developing and perfecting high speed engines. This latest engine is the joint production of F. H. Ball, the well-known engine designer, and his son F. O. Ball.

In the early days of high speed engines there was great similarity in the valve gears of all makes, but in later years there has been a divergence in the line of development followed by designers of this class of engines. Some have sought a refinement of efficiency by the use of complicated valve gear. Others have claimed that the increased cost of maintenance of complicated valve gear on high speed engines, and the greater liability of interrupted service, more than offsets the small gain in efficiency that may be realized from a multiplication of the valves and valve mechanism, and that where high efficiency is desired a much better plan is to use a compound engine of simple design, because it is vastly more economical of steam than any simple engine even with the most complicated valve gear. Mr. Ball and his son have consistently held to this view and have sought to attain the extreme of simplicity and fewness of parts. The well known duplex-compound engine is in this line of development, and now this newest engine called the "angle-compound" is another step in the same direction.

The general plan of combining a horizontal engine and a vertical engine so that both shall work on the same crank pin is not new. There are conspicuous examples of this general type in the giant engines installed in the traction power houses of New York city, but engineers do not seem to have appreciated the many desirable features of this arrangement for high speed engines of the single valve type.

It is well understood that with reciprocating engines the question of counterbalance becomes increasingly important and serious as the speed is increased. A very erroneous idea is somewhat prevalent to the effect that reciprocating engines may be counterbalanced so that the thrusts of inertia are neutralized. Nothing could be further from the truth, because a counterweight attached to the heel of a crank merely transfers the unbalanced thrust from the plane of the reciprocating parts into a plane at right angles to it. Thus in a locomotive the counterweight in the driving-wheel, which is absolutely necessary to keep the engine from "nosing" violently at high speeds, simply transfers the unbalanced thrust to a vertical plane. Recent experiments with a locomotive testing equipment have shown that at high speeds this vertical thrust becomes so great that when the counterweight passes over the shaft, the wheels, with the weight of the engine on them, are actually lifted clear of the track. This seems incredible, but has been abundantly demonstrated.

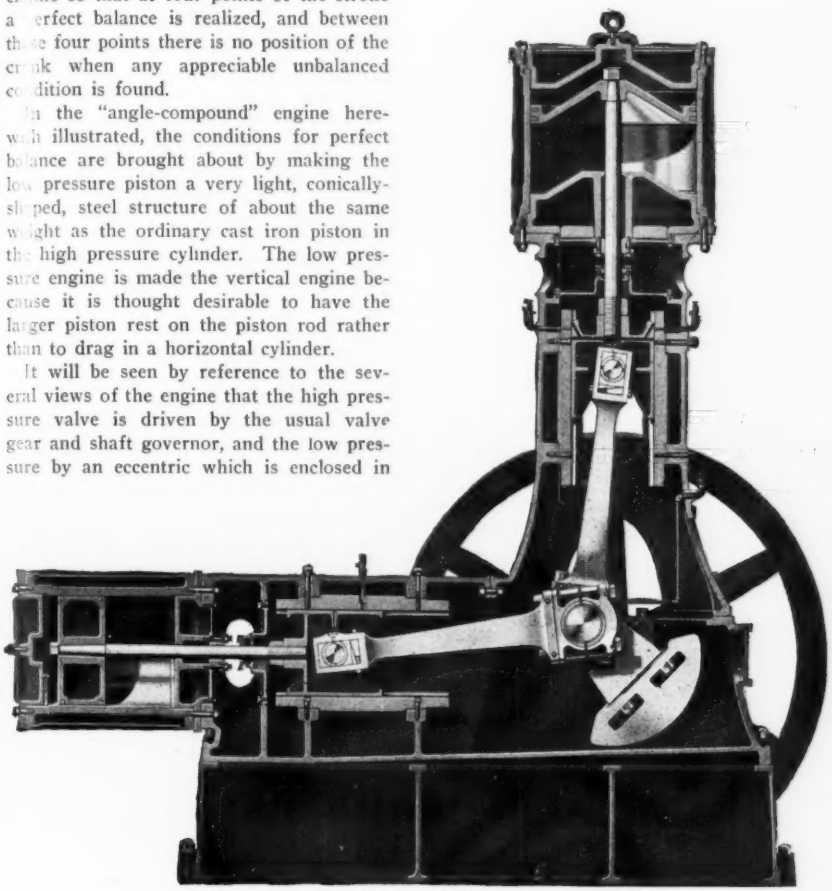
The casual observer of high speed engines does not understand that with a horizontal engine the inertia thrust of the reciprocating parts which will rock a foundation badly will, if transferred into a vertical plane, be easily resisted by the same foundation. The engine then has no rocking tendency, and, therefore, seems to be balanced.

The usual practice of engine designers is to counterbalance to the extent of transferring the largest part of the horizontal

thrust to a vertical plane, leaving only such an amount of horizontal thrust as will be safely resisted by the usual foundation. Keeping this in mind it is evident that by combining a horizontal and vertical engine on the same crank pin the total amount of horizontal thrust may be neutralized by counterbalance; and when the counterweight is in a vertical plane it is opposed by the reciprocating parts of the vertical engine so that at four points of the stroke a perfect balance is realized, and between these four points there is no position of the crank when any appreciable unbalanced condition is found.

In the "angle-compound" engine herewith illustrated, the conditions for perfect balance are brought about by making the low pressure piston a very light, conically-shaped, steel structure of about the same weight as the ordinary cast iron piston in the high pressure cylinder. The low pressure engine is made the vertical engine because it is thought desirable to have the larger piston rest on the piston rod rather than to drag in a horizontal cylinder.

It will be seen by reference to the several views of the engine that the high pressure valve is driven by the usual valve gear and shaft governor, and the low pressure by an eccentric which is enclosed in this crosshead and guides are also included in the oil circulating system of the engine. This oil circulating system is similar to that used on the American-Ball engines with which engineers are familiar except that the oil is pumped directly to the gravity storage tank on the low pressure frame which is kept constantly overflowing by the supply delivered to it from the pump.

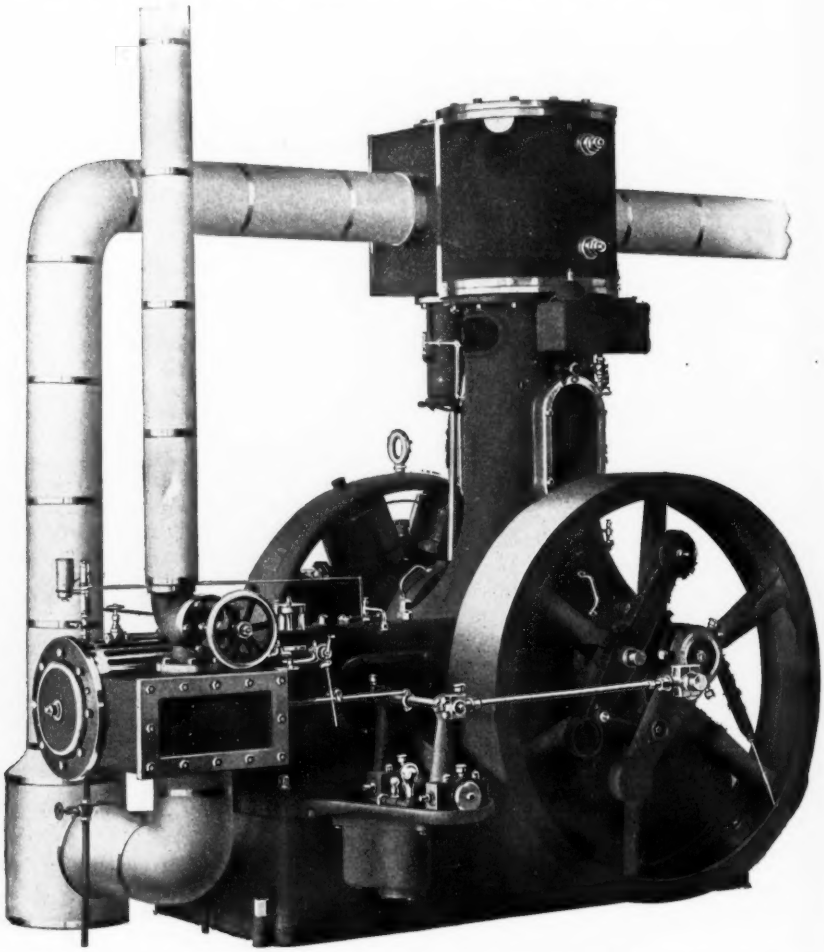


an oil tight casing and connected with the oil circulating system of the engine. From this eccentric a rod drives direct to the low pressure valve stem, which is guided by a crosshead carried in guides as shown, and

A double stuffing box on the valve stem and bulk heads, and stuffing boxes on both piston rods prevent the water drip from mingling with the oil of the circulating system. The water drip from all these stuf-

fing boxes is carried off by concealed piping so that the engine is never untidy in appearance.

A new departure has been made in this engine in the arrangement of the crosshead and guides, which are of the bored type. It will be noticed that the crosshead is a single piece without the usual adjusting shoes, while the guides are made adjustable. These guides are carried in bored seats and a projection from the back of the guide fits between the supports so as to resist end thrust. One of the guides is secured to the support by screws, and is only adjustable by means of shims, but the other has a pair of screws at each support to provide for delicate adjustments, and the guide is securely held against these adjusting screws by a bolt that locks the adjustment securely when set up.



It is, of course, understood that the crank pin is double the usual length, and that the connecting rods are placed side by side on this double length pin. This completes the general description of this new and interesting engine.

The builders' claim that this type of engine runs more smoothly and with much less strain and shock than any other form of high speed engine, because of its perfect balance, and because it has four small impulses on the crank at each revolution instead of two large ones, would seem to have justification. They have recently installed in their own power plant one of these new engines of 160 H. P. 11-inch stroke running about 300 R.P.M., direct connected to one of their generators. This engine has no special foundation, except the concrete floor of the building and has not a single foundation bolt. A new full length lead pencil was stood on its end on the horizontal cylinder head and then on the vertical cylinder and there was not vibration enough to disturb the delicate balance of the pencil even with a fluctuating load on the engine.

It is apparent also, that this is the only form of reciprocating engine that can really be counterbalanced, and it is, therefore, better suited to high speed than any other type of reciprocating engine.

It is evident also that the floor space of this engine carries a vertical engine of zontal engine carries a vertical engine of the same power, the power for a given floor space is, therefore, doubled. This also reduces the cost of foundation to the same extent, so that practically half the foundation is saved; besides the perfect balancing of the engine makes the foundation problem such a very simple one, that where concrete floors are used, no further foundation is ordinarily required, thus saving the entire cost of foundation.

For large powers these engines, combined in pairs with the generator or belt wheel between them, make an exceedingly compact unit. In these combinations the engines are used as double compounds when run non-condensing, or where condensing water is available, as four cylinder triple expansion engines. In the latter case one horizontal engine is the high pressure, the other horizontal the intermediate pressure and the two vertical engines combined are the low pressure, thus giving a large area of low pressure piston without using any pistons of very large diameter. Since the normal speed of an engine of this kind is high, the cost of the generator, and the amount of floor space are both greatly reduced.

The American Engine Company reports that the increased business consequent upon the manufacture of these new engines has necessitated a large addition to their plant at Bound Brook, N. J., where even in these troublous financial times they have for some weeks been running both day and night shifts.

Electrical Equipment of Hydro-Electric Plant.

THE General Electric Company is furnishing complete electrical equipment for a hydro-electric plant in Nagoya, Japan, a city with a population of about 250,000, situated some 300 miles from Yokohama. The main generating station will be built at Yawozo on the Naiko river, where power will be generated at 6,600 volts by four three-phase 2,500 kw. 60 cycle, 360 r.p.m. water-wheel driven generators. The generator voltage will be stepped up to the line voltage of 60,000 volts by 12 water cooled transformers of 1,000 kw. capacity each, and transmitted 30 miles to the main sub-station just outside of the city of Nagoya. Here the line voltage is to be stepped down to 11,000 volts by 9 water cooled transformers of 1,350 kw. capacity each, and transmitted underground to the distributing station through triple conductor lead armored cables, the city ordinance prohibiting an overhead transmission of over 3,500 volts.

In the central distributing station the voltage will be stepped down to 3,400 volts by 9 water cooled transformers of 1,350 kw. capacity each, at which potential it is to be distributed throughout the city by both overhead and underground cables.

It is interesting to note that from the nearest railway station the entire power apparatus for the Yawozo station will have to be transported on specially constructed wagons drawn by oxen.

The Naiko River is normally 40 feet in depth, but in the rainy season the river often rises to 40 and 70 feet above low-water mark. This rising characteristic of the river will necessitate the building of a specially designed dam to take care of the high water.

An Innovation in Feed Water Heaters.

ENGINEERS are generally familiar with the old rule of thumb that for every 10 degrees Fahrenheit that feed water is heated before entering the boilers, 1 per cent. less coal is required to evaporate the water into steam. Also that for each 10 degrees Fahrenheit increase in feed water temperature, the boiler capacity is also increased by 1 per cent.

Many tables have been compiled, showing the total cash savings per horse power in plants of different types and with coal at different prices, and it is probably well within the fact to state that there is no single piece of power plant equipment that returns a larger dividend on its investment than a proper feed water heater.

The feed water heaters in common use in stationary power plants divide themselves into four general types. First, the open heater with the exhaust steam in direct contact with the feed water; second, the straight tube heater; third, the inverted U-tube heater; and fourth, the pipe coil heater, usually with pipes of several different curvatures. Each type has its advocates, but experimentation and test have clearly established the fact that the efficiency of most feed water heaters leaves much to be desired. The heater described in the following paragraphs represents a new departure in stationary power plant practice. It is the Reilly "multicoil" feed water heater.

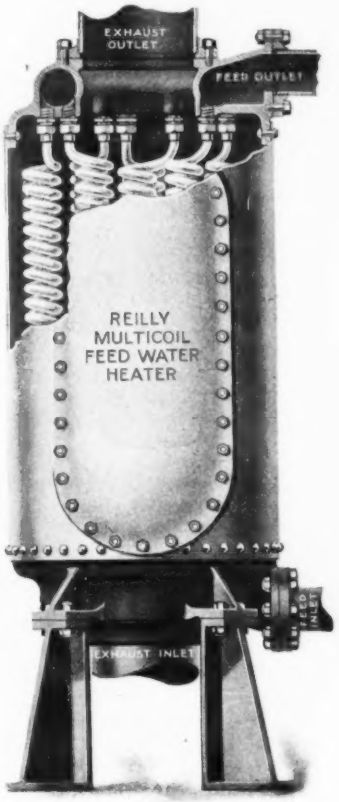
Among marine engineers, on merchant ships and in a large number of government vessels, the Reilly multicoil heater has long been regarded as an established standard. On shipboard weight, space occupied, and reliability are very important features and of no less importance is high efficiency. Therefore, the mere statement that the Reilly heater has established itself for shipboard use is equivalent to a demonstration of its compactness, light weight, ready accessibility for inspection and repair, together with the essential qualities of strength and simplicity.

It is, perhaps, surprising that a successful piece of steam plant equipment in the marine field has been so long in entering the domain of stationary engineering, but the apparent explanation seems to be that there is but little communication between the two branches of steam engineering, and further, that the James Reilly Repair & Supply Co., which for many years manufactured the Reilly multicoil heaters, had always confined its work almost exclusively to marine installations. This company has recently been enlarged and reorganized under the name of the Griscom-Spencer Co., as consulting contracting engineers in both marine and stationary power plant work, and they are now manufacturing a line of feed water heaters, embodying the essential characteristics of the successful marine types, but adapted to stationary power plant practice.

Referring to the accompanying illustration, the heater will be seen to consist of a shell of boiler plate with riveted seams and provided with a large removable door making the interior easily accessible for cleaning, inspection or repair. At the top and bottom of the heater are headers or manifolds of cast iron, or cast steel as required by the particular conditions, and provided with suitable flanges for the attachment of the inlet and exhaust pipes and feed inlet and outlet. Connecting these headers are a large series of small diameter, copper coils. These coils are rolled from seamless drawn copper tubing of small diameter and therefore of light gauge metal. Connection between the coils and headers is made with screwed union joints ground to a steam tight fit without packing and gaskets. Brass nipples are securely brazed to each end of the coils, the joints being afterward tested to 250 lbs. The number of coils in each heater depends upon the capacity required.

Exhaustive tests have proved the unusually high efficiency of this arrangement of coils. It is not uncommon in other types of closed heaters for the water flow to follow certain lines of least resistance, so that it is found by experiment that the flow is very sluggish through certain tubes, scarcely any flow through some tubes, and that a few of the tubes are doing nearly all of the work. Naturally where any air pockets or "dead tubes" occur just that much heating surface is put out of commission and the capacity and efficiency of the entire heater lowered in proportion. The small diameter of the coils in the Reilly heater brings about three important results. First, the distribution of flow between the differ-

ent coils is found to be almost identical, which means uniform circulation throughout all parts of the heater. Second, the violent agitation from the rapid swirling motion is of the greatest benefit in promoting the rapid absorption of heat, and third, the same swirling action prevents any deposit of scale or sediment in the tubes.



Reviewing these points in more detail: On account of the high velocity of the flow under all conditions, the slight frictional resistance offered to the water passing through the coils has proved to be such as to automatically regulate the flow between them, in so much as the pressure drop through the coils varies sensitively with the velocity of the flow. If, therefore, the velocity increases even slightly, the pressure drop immediately increases in far greater proportion with the result that the flow through that coil in which this pressure drop has been caused to increase is immediately cut down until equal with the others, and in this way the regulation is automatic. The Reilly multicoil heater is designed to give a pressure drop through the heater of from one to one and a half pounds. Experiments have shown that the efficiency of heating surface and the rate of absorption of heat by water is directly proportional to the extent and rapidity of the agitation of the water. In other words, convection is much more important than conduction for the absorption of heat in a feed water heater. Copper is about 500 times as good a conductor as water, but water in a thin film will absorb heat almost instantaneously from walls of a copper tube. In a straight tube, or in one with only a little curvature, and where the tube diameter is not small, there is no element to cause violent agitation of the water which would result in a continual changing and replacement of the particles of water forming the film in contact with the hot tube wall. Therefore, in order to heat the central core of water in the tube it is necessary to rely largely upon the heat-conducting ability of water itself, which, as mentioned above, is exceedingly poor. If, however, the water be thoroughly agitated, so that every particle comes often in contact with the heating surface, it would be natural to suppose that the rate of transfer of heat would be immediately increased. This proves to be the case exactly, and constitutes the fundamental principle underlying the use of small diameter copper tubing and small radius coils. In the Reilly heater the water necessarily passes through at high velocity and is violently thrown by centrifugal force against the wall of the tube in passing through the spiral, back and forth, so that positively there can be no sluggish central core of water.

A very simple experiment which may be performed by anyone to confirm the foregoing statements with regard to the importance of agitation in promoting the rapid absorption of heat from water from metal may be performed as follows:

A metal tube, like a piece of pipe closed at one end, should be filled with very hot

water and immersed gently in a pail or basin of cooler water and allowed to remain at rest until its temperature has fallen, as measured by the thermometer let us say, 100 degrees, or to the temperature of the surrounding water. The time required for such cooling should be observed. If the same tube is again filled with hot water as before, and instead of being allowed to remain quietly in the pail or basin of cool water should be stirred around and around rapidly until the thermometer shows that it has cooled down to the lower temperature observed in the first experiment, it will be found that the time required for cooling in the case of agitation is about one-third the time required for cooling under the first stagnant condition. The principles involved in such an experiment are identical with the conditions outlined above in feed water heater construction.

An exhaustive series of tests conducted last year by J. B. Spencer, M.E., of the Griscom-Spencer Co., in the steam laboratories of Columbia University, proved beyond question the enormous increase in efficiency per square foot of heating surface in the small copper coils of the Reilly heater over that shown by many of the older types of feed water heaters in which larger coils or loops are employed producing much less agitation of the water in passing through them.

The Reilly multicoil feed water heaters are manufactured in 23 different stock sizes, from 45 up to 5,850 horse power, and it is of interest as showing the capacity of this type of heater and its small size that the diameter of the 5,850 horse power heater is only 4 feet 8 inches and its height between top and bottom exhaust flanges 4 feet 11 inches.

The Reilly multicoil feed water heater is made by the Griscom-Spencer Co., 90 West Street, New York.

The Badger Ventilator.

THE Badger ventilator utilizes a principle long known and applied in other branches of mechanical service but entirely new, we believe, in the special field of ventilation. Its operation is definite and positive; its construction is extremely simple; it therefore offers a reliable, practical and economical solution of the problems of smoky chimneys and ill-ventilated rooms.

This ventilator applies the energy of external air currents, even the slightest of such currents, to produce a suction in the chimney or ventilating flue. At the same time it does not diminish the area of such flue, and therefore avoids the objectionable features of many previous devices.

Its action resembles that of the common locomotive injector, which, although a

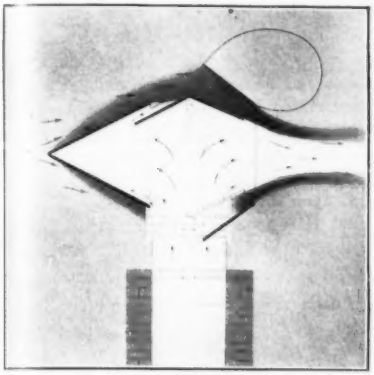
seeming paradox, is universally used successfully on boilers. This latter device utilizes a jet of live boiler-steam which, flowing from a special nozzle, gives sufficient pressure and velocity to a jet of water to force it into the boiler against the very pressure at which the steam emerges. To illustrate the action of the Badger ventilator we have prepared a diagram of air currents. The air pressures existing at a given moment are roughly indicated by the degrees of shading, and the briefest examination will give an idea of the way in which the ventilator produces a flow of air out of the cowl.

Heavily shaded areas indicate compression of external air. White areas show the partial vacuum which results from operation of ventilator.

The ventilator being pivoted freely upon a hardened steel center and pointed rod, its vents always open away from the wind. The frictionless bearings and the large vane cause the ventilator to respond to the slightest movement of air. The external air,

flowing as indicated by the arrows in the diagram, is caught by the large end of the conical deflector and is compressed in flowing through this passage between its converging walls. The result is that the air that leaves the deflector at a higher velocity. Hence the (right hand) opening of the hood is surrounded by a tube-shaped jet of compressed air.

Accordingly at the outlet of the cowl a partial vacuum is set up which can be relieved only by drawing air from the cowl.



This process is continuous, and results in a steady outward draft.

At the left hand end of the ventilator is another differently shaped conical deflector with its point to the wind. Air flowing against this point is "split" or deflected, and is considerably compressed by the time it reaches the edge or base of the cone. A partial vacuum is therefore created inside this edge and the interior air is sucked out.

Hence the ventilator has a double action, its contained air being sucked out at both apertures. The combined area of these openings is nearly double that of the flue.

The manufacturers are the Badger Ventilator Co., 40-55 Pitts Street, Boston, Mass.

U. S. Reclamation Plant.

THE United States Reclamation service, a bureau under the Department of the Interior, is accomplishing much in the way of irrigation of large arid districts in the Western portion of the country, converting them into highly productive farm lands. Among the various projects under accomplishment by the Reclamation Service is one in the vicinity of Garden City, Kansas, known as the Garden City Project. The Arkansas river, which flows through this section of the country, is a large body of water in the wet season, while in the dry season its bed is practically dry. There is, however, a considerable body of water flowing a short distance below the surface of the ground. The Garden City Project consists of a power plant and twenty-three separate electrically driven pumping stations, located along the line of flow of the underground water, to make available this water for irrigation purposes by pumping it to the surface in times of drought.

The area affected is a strip of land approximately ten thousand acres, extending from the Arkansas river northeast for about twenty miles. During the wet season the water for irrigation purposes is taken from a canal fed by the Arkansas river, known as the Farmers' Ditch. At the junction of the Arkansas river and the Farmers' Ditch are a set of flood gates, arranged so that when the water in the river is at a sufficiently high level it flows into the ditch, feeding desired tributaries. When the water in the river falls below the requisite level to feed the ditch, the supply is pumped from the underground water by the various pumping stations into the canal, and the flood gates are closed.

The entire plant is of the most efficient and modern type in all details, a high economy of operation being secured.

There are two 200 H.P. Sterling boilers, set singly for generating steam at 150 pounds pressure. Each boiler being supplied with a superheater which superheats the steam to 120 degrees F. leading from the coal supply house outside the power house there is a small steel track; and there are two one-half ton fuel cars which cart the coal into the boiler room. The steel stack is 150 feet high.

The turbine generators are 225 K.W. each, 6,600 volts, 60 cycle, 3 phase, with exciter direct connected to the shaft of each of the generators. The turbines are designed to operate at their best efficiency at 150 pounds steam at the throttle, 100 degrees superheat, condensing into 28-inch vacuum. Turbines are fitted with an auto-

matic system for filtering and supplying machines with oil.

The switchboard consists of five panels of marble; two panels are for the generators, one panel for the exciter and two panels for line service. On the generator panels and the line panels are switches which are connected with oil switches. These latter being in the basement below the switchboard, and are operated mechanically from the board. The installation of the oil switches in the basement, also the transformers and the various connections constitute quite an elaborate system, and it was necessary that this be installed with the greatest caution. The cut illustrating the basement gives a very good idea of the connections to the transformers, oil switches, etc. The condensers, of which there are two, are surface condensers manufactured by the Wheeler Condenser & Engineering Company, each condenser being fitted with Edward's vacuum pump. Each condenser has a capacity for taking care of 5,200 pounds per hour, maintaining vacuum of 1½ inches absolute with cooling water at 65 degrees F.

The plant was installed by the D'Olier Engineering Co., 119 South Eleventh Street, Philadelphia.

Ventilation of the Washington Terminal Tunnel.

VENTILATION of the tunnel through which trains reach and depart from a new Union Terminal at Washington, D. C., has been accomplished along lines and by methods that make the installation of special interest. The problem was that of removing from the tunnel all trace of gas and smoke left by one passing train before another train should enter the tunnel. This called for a high output of air, although the circumstances were such that the ventilating apparatus must be confined to a very small space and attain high efficiency at a low expenditure of power.

At a point about 300 feet from the terminal portal were constructed two ventilating ducts each about five feet wide, which are carried along both side walls of the tunnel to the full height of about 18 feet, with a cross duct under the tracks. The space available for the fans on which was imposed the duty of clearing the tunnel of smoke in a few minutes time, was 18 feet high by 13 feet in width. In this space it was necessary that the fans and casings should be erected.

The specifications imposed by the Pennsylvania Railroad Company called for two fans 120 inches in diameter, each capable of delivering 200,000 cubic feet of air per minute against a 1½-inch water gauge. The speed was not to exceed 145 revolutions and the power requirement was limited to 120 horse power.

The fans installed are of the Sirocco design, with double inlets corresponding in dimensions, efficiency, speed and power requirement to the specifications just noted. These fans, driven by electric motors, have now been in use for several weeks, and have satisfactorily performed the duty imposed upon them.

Fans of this design represent a distinct development in the science and construction of centrifugal blowers. In a large number of important installations abroad, and aboard the latest vessels of the British Navy, the White Star Line, Cunard Line, Hamburg-American Line, American Line, and others, they are now adopted wherever the requirement is for high output in connection with limited space.

The outer edges of the blades are bent forward to a set angle in the direction of rotation, and are very slightly cupped. The inlet and outlet of the fans are practically equal to the area of the fan itself. The special advantage of the size and shape of the blades is that power-absorbing eddies are almost entirely eliminated and the velocity of the air so greatly accelerated that it actually exceeds the peripheral speed of the blades by as much as 70 per cent. The intake draft of the fan shows practically no variation over its entire area.

In tests of smaller sizes of fans it has been found that a Sirocco centrifugal fan 30 x 22 x 33 inches delivers 2,200 cubic feet of air per minute more than the fan of ordinary type 42 x 34 x 39 inches. As already noted, on shipboard, in mines, and in many other installations, this high output as compared to the small space occupied by the fan is of paramount importance.

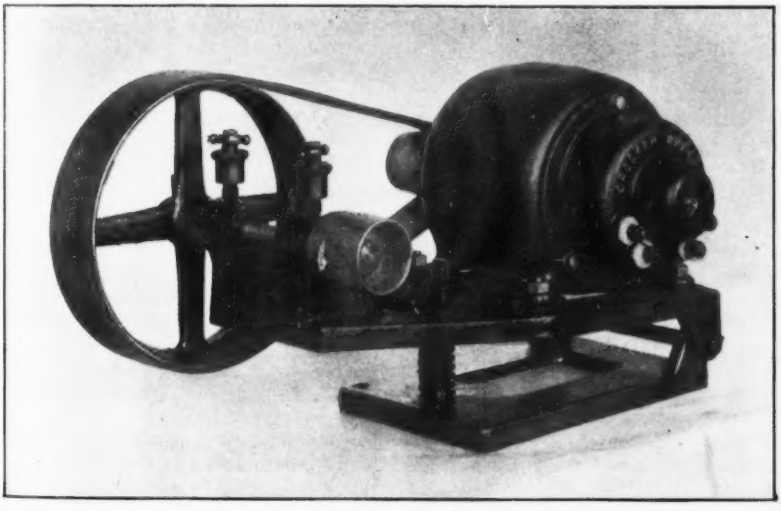
The power absorbed by the Sirocco fans

is indicated above in the specifications limiting the requirement for a fan capable of delivering 260,000 cubic feet of air per minute against a 1½ water gauge to 120 horse power.

In addition to the installations already mentioned, Sirocco fans are now installed in the Flatiron Building, Broad Exchange Building, and Hotel Astor, New York city; Union Station, Pittsburgh, three power houses of the Brooklyn Heights Railroad Company, the New York Edison Company, and a number of coal and copper mines, but have not heretofore been manufactured in the United States. They are now made here by the Sirocco Engineering Company of New York, of which William C. Redfield, formerly of the J. H. Williams Company, is president; Hugh T. Coulter, for several years manager of the New York branch of the Davidson Company, general manager, and Thomas Brown, chief engineer.

Countershaft Belt Tightener.

AN ingenious and simple device for tightening the driving belt of an electric motor has just been perfected by the Crocker-Wheeler Company and is shown in the accompanying illustration. It consists of a countershaft and a simple and effectual belt tightener. Though designed for the peculiar requirements of linotype machines, it can be used to advantage with any machinery requiring slow speed drive.



The device consists of a cast iron base on which are mounted the motor and countershaft. The base is pivoted at one end to a sub-base, and belt tension is produced by means of an adjustable nut at the other end. A spring is provided to support the movable base in case of breaking of the belt. The belt between motor and countershaft is tightened in the usual way, by shifting the motor on the movable base with the aid of an adjusting screw.

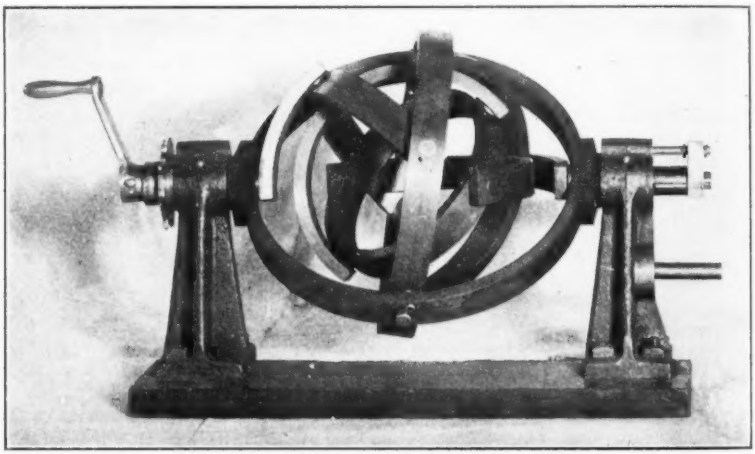
It will be readily seen that this device is much more effective than a simple idler. Not only does it keep tension on the belt, but by the use of the countershaft a great difference between sizes of driving and driven pulleys is avoided, and the belt therefore makes contact with a greater arc of the driving pulley, with consequent absence of slip.

The motor is of the Crocker-Wheeler L type, made in sizes from 1/20 to 5 horse power. Of neat appearance and compact design, it is especially suited for application to small tools, printing presses, pumps, and all kinds of light machinery. Thousands of applications have been made with the form L motor, which has become a standard machine. By means of simple covers for the

openings in the frame, the motor is easily rendered dust and moisture-proof, in cases where an open type of motor would be out of the question.

A Positive Speed Change Without Gears.

A VERY interesting mechanical device, the invention of Henry M. Russell, Jr., of Wheeling, W. Va., is illustrated in the accompanying photograph, taken from a working model of the mechanism. While this model does not represent the full development of the design, lacking (for example) the counterbalancing of the unbalanced moving parts, and other features which might appear in the more finished machine it serves to make clear the ingenious construction employed to produce the results.



As will be seen, the essential elements are three aligned shafts, connected by conic linkwork in such manner that they are free to rotate about their common axis so that the angular velocity of one of the shafts shall be a mean between the angular velocities of the other two, but not to rotate otherwise. The conic linkwork is made up of six cylindric pairs of elements whose axes are not parallel but intersect at a finite distance. The system is movable, since it fulfils the condition that all the axes pass through a common point. Every pin and every hole points to the common center in every possible position of the links.

The device produces without toothed gearing the same movements that are produced by the balance gear of a motor vehicle. That is, if the central member be held stationary the rotation of one shaft will produce an equal and opposite rotation of the other shaft. If one shaft be held stationary the rotation of the other shaft will produce a rotation of the central member at half speed. The device may therefore be used as a balance gear or differential, as a reverse, or for the purpose of driving a machine at one-half the speed of the motor. For the last purpose it may be equipped with clutches such as are employed in planetary speed-changing devices and the speed of the driven machine may then be changed at will from full speed to half speed.

The advantage of this device over gear wheels is that there are no teeth going into and out of mesh but all the connections are permanent and the action is simply a crank action. This gives a smoother action than toothed gearing and eliminates the noise incident to the latter and the danger of breaking the teeth. Furthermore the motion at every bearing is simply rotation; a ball bearing may be used at every point where friction would occur and sliding friction may thus be altogether eliminated. This would mean a high efficiency as compared with gears.

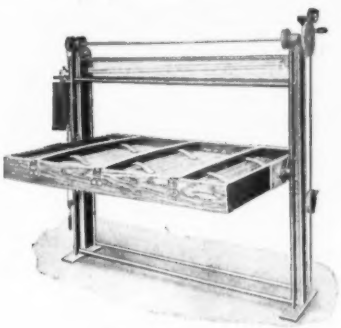
By suitable counterweights rigidly attached to the crank members the device may be balanced so that the centre of gravity will always be exactly at the centre of the device.

One of the most interesting features of the model is that although there are only two cranks for the two systems of link work the dead centres are about ninety degrees apart.

Since the speed reduction is exactly one-half, the same device may be used on a motor car as a substitute for both the cam gears and the transmission gears.

New Blue Printer.

IN a series of bulletins entitled "Everything for Blue Printing," the C. F. Pease Blue Print Machinery & Supply Co., of 22 Fifth Avenue, Chicago, present a number of unique and interesting features in improved blue print machinery. The latest device brought out by this company is the P-M automatic electric blue printing machine, an illustration of which is here shown. This machine is designed to meet the requirements of the architect, engineer and manufacturer whose blue printing is not sufficiently voluminous to warrant a large outlay in apparatus.



READY TO LOAD.

Heretofore an electric blue printing machine has necessitated the expenditure of several hundred dollars, not to mention the amount of floor space required, which as a rule is more than can be conveniently devoted to such purpose.

The general plan of this machine is that of a pivoted blue printing frame with automatic means of passing a mercury vapor lamp across the face to make the necessary exposure. The lamp is a Cooper-Hewitt and throws off no more heat than an incandescent. It is therefore placed so close to the printing frame that the printing efficiency is many times greater than is possible to secure with an arc lamp at the distance which it is necessary to place it from the work in a cylinder machine. The

READY TO PRINT.

lamp mounting is constructed inside a well ventilated reflecting box, guided between uprights of the main frame of the machine, and supported by cables attached to the speed-controlled shaft at the top of the machine. Every precaution is taken to guard against any possible accident to the lamp which is so mounted as to minimize any possible jar which might occur in handling. The exposure is automatically controlled by a pendulum type escapement, by which the time required to pass the light across the frame can be accurately regulated. The current consumption for each size is the same, requiring 3½ amperes, which at 110 volts makes the total cost of operating the machine less than two cents per hour.

The various processes that can be printed by sunlight can be handled to advantage upon this machine. The high efficiency is due: First, to the source of light being rich in chemical rays, there being practically no energy lost in non-actinic light; second, the nearness of the light to the sensitized paper, made possible by the lack of heat in the type of lamp used. The space occupied is 12 inches in width by 30, 54 and 60 inches in length, for sizes A, B and C, respectively,

or about the same as a steam radiator. Each of these machines stands about 52 inches high. The simplicity of construction and operation permits the machine to be handled by a novice with safety and efficient results. The electrical equipment is complete in detail, including all the necessary wiring, with switch, fuse block and resistance coils, so that it is only necessary to connect the two electrical leads to the provided binding posts, which can be done by any electrician in a few minutes.

Berquist Storage Bins.

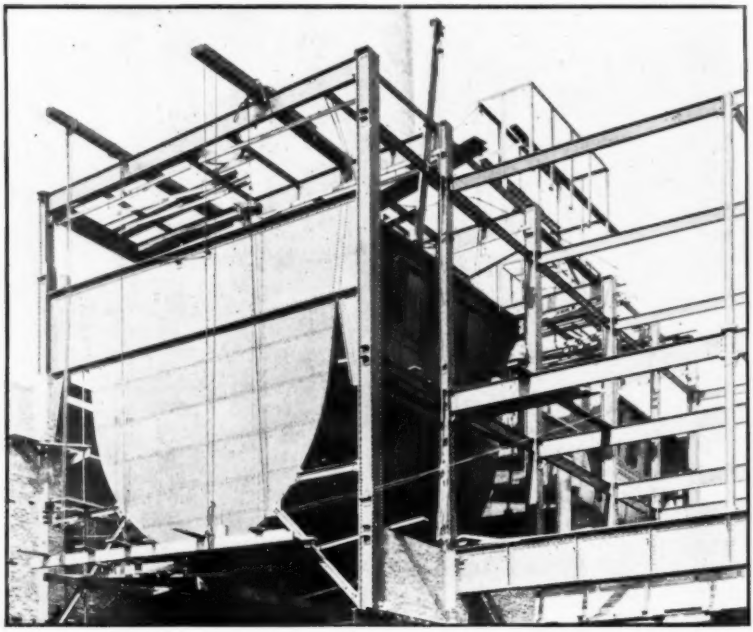
WE illustrate herewith part of the coal handling system for the Philadelphia Rapid Transit Company, of Philadelphia, Pa., as built for them by A. Samuel Berquist, of 1571 Forty-seventh Street, Brooklyn.

The storing of coal in overhead bins is done on the well known Berquist system. Three installations of this kind have been completed and are in successful operation by this railroad company; the first being done in 1900, the second one in 1903, and the last one has lately been completed.

The advantages of the Berquist system are claimed to be its first low cost of installation, and its immunity from spontaneous combustion of coal in the bins.

Mr. Berquist claims to have one of his bins in use at the Lackawanna Steel Company's plant, which is 50 feet wide, and the pile of coal is approximately 50 feet high; however, the cooling of the coal in the bin is so perfect that the coal has never been on fire in this huge pile.

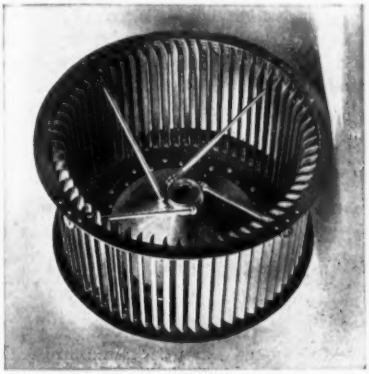
At the re-modeling of the National Tube Company's plant at McKeesport, Pa., the Berquist bin was used exclusively. Some fourteen bins in all were installed in connection with this improvement.



Evolution of the High Pressure Fan.

THE evolution of paddle-wheel blowers, built first for small volumes at high speed and then for large volumes with low speed, is familiar. There has been a general understanding that the turbine-type of fan introduced entirely new principles in

construction—so new indeed as to amount to a complete reversal of ideas prevailing up to eight or ten years ago. In the ordinary centrifugal fan the blades are of greater length radially than their surface measurement parallel with the shaft, and the number of blades seldom exceeds 12. In the turbine fan, however, of which the "Sirocco" fans invented and manufactured by S. C. Davidson, are the earliest examples, the radial measurement of the 64 blades ordinarily employed is much less than their surface measurement. So radical was this departure it was declared theoretically that such an arrangement was incapable of setting up true centrifugal action, and that while it might answer for low pressures or free discharge it would be useless against high water gauges. In actual service for the last eight years, however, these fans have demonstrated that they are as efficient at 30" water gauge as at 1", and that they are as capable as centrifugal pumps for high or low lifts as they are for the propulsion of air.



Considering only these facts, and eliminating the difference in the size of inlet and outlet (which in the Sirocco fan, as can be seen, are practically equal to the area of the fan itself, while in the ordinary fan the proportion seldom exceeds one-half or at most two-thirds) and the difference in eddying action, it seems clear enough that the turbine fan is as wide a departure in principle as it is in practice and performance from the paddle-wheel blower.

But this is by no means the whole story. In the Sirocco fans the blades are curved forward in the direction of rotation with the result that not only are noise-producing and power-absorbing eddies eliminated, but the velocity of air discharged is so greatly accelerated that it exceeds the peripheral speed of the blades by more than 70 per cent. In a number of tests the speed of discharge has exceeded the rate of rotation of the tips of the blades by 77 to 80 per cent. This is an important factor in determining mechanical efficiency. For example, in a 25-inch Sirocco fan in actual use at 300 revolutions a minute the tips of the blades have a speed of 1,962 feet per minute, but the actual velocity of the air is 1,962 plus 80 per cent., or 3,532. The volume of discharge, 8,000 cubic feet per minute, figured at a velocity of 3,532 lineal feet per minute, shows a very high degree of efficiency per unit of power.

The multivane turbine fan is the invention of S. C. Davidson of Davidson & Co., Ltd., Belfast, Ireland, who built the first fans of this type prior to 1899, and has since manufactured and sold them all over the world under the name of Sirocco fans and blowers. The English patents date from about the same time, and the 37 United States patents on the same invention (first applied for in 1898) are dated from 1900 up to 1907. In granting the basic patent the Board of Examiners-in-Chief of the United States Patent Office said:

"The fan has been proved to be very largely more efficient and much less noisy than fans of other types of the same size. We are disposed to allow all claims which indicate the distinctive features and functions of the fan in order that the patentee may have a standing in court which will call for a determination of the most extreme breadth of his invention."

Under this basic patent of 1900 the Sirocco fans are now being made in the United States by the Sirocco Engineering Co., 138 West Street, New York, which has acquired the sole right to the Davidson patents in this country.

NEWS SUPPLEMENT

The Engineering Magazine—March, 1908

Personal.

—William J. Seaton, Jr., 2d vice-president of the C. W. Hunt Co., West New Brighton, N. Y., died at his home at Clifton, Staten Island, on January 18 from typhoid fever at the age of 36.

—John Fritz, of Bethlehem, Pa., the well-known metallurgical engineer and veteran iron master, has been elected a member of the Board of Trustees of Lehigh University and has accepted the position.

—W. B. Updegraff, who has recently become connected as mechanical engineer with The Harlem Contracting Co., 201st Street and Harlem River, New York City, would be pleased to receive catalogues of mill supplies and general shop equipment.

—Wynn Meredith, Member of the American Institute of Electrical Engineers, has become a partner in the firm of Sanderson & Porter and will have charge of the Western office which they have opened in the Union Trust Buiding, San Francisco.

—Announcement is made of the appointment of Professor C. F. Harding as head of the School of Electrical Engineering of Purdue University. Professor Harding is a graduate of Worcester Polytechnic and has had a broad practical training as an engineering teacher.

—Orrin S. Werntz, treasurer of The National-Acme Manufacturing Co. since its organization, died February 6, 1908, age 32. Born in Canal Fulton, Ohio; removed to Cleveland early in life. First position was with The National Screw & Tack Co., until the organization of The National-Acme Manufacturing Co.

Industrial Notes.

—International Steam Pump Co. have removed their general offices to 115 Broadway, New York. The repair shops will be located at 44 Trinity Place, New York.

—The Northern Electrical Manufacturing Co., Madison, Wis., announces the removal of its St. Paul office from 21 East Fifth Street to 516 Endicott Building, St. Paul.

—The Pittsburgh Valve & Fittings Co. announce that they have removed their general offices to Barberton, Ohio, and that all communications should be addressed to that office.

—Hammond Iron Works, Warren, Pa., have issued a tankage scale giving the dimensions, specifications and capacity of tanks ranging from 3 feet to 30 feet in height.

—Charles G. Smith Co., Park Building, Pittsburg, wish to deny the report that has been circulated that owing to their connection with the Pittsburgh Emery Wheel Co., it is their intention to discontinue the machine tool business.

—Robert McF. Doble, consulting and supervising engineer, making a specialty of hydro-electric power development and transmission, formerly of San Francisco, announces the removal of his office from Colorado Springs to 528 Majestic Building, Denver.

—The Great Western Portland Cement Co. has placed an order with the Lehigh Car, Wheel & Axle Works, Catasauqua, Pa., for Fuller-Lehigh pulverizer mills for both the raw material and clinker departments of their two thousand barrel cement plant being erected at Mildred, Kans.

—At the annual meeting of the stockholders and directors of The American Tool Works Co., Cincinnati, the following officers were elected: Franklin Alter, president; J. B. Doan, vice-president and general manager; R. S. Alter, secretary; and Henry Luers, treasurer.

—Owing to the increase of business from the states of Louisiana, Mississippi and Texas, the Potter Separator Co., Newburgh, N. Y., have opened a branch office in the Hibernia Bank Building, New Orleans, under the management of A. M. Warner.

—The Western Electric Co., Chicago, are about to issue a new bulletin covering the Beck flaming arc lamp, fully descriptive of the most recent and important developments and with full data covering performance. Lamps as now manufactured are suitable for use on either alternating or direct currents.

—The Hawkeye Portland Cement Co. has placed an order with the Lehigh Car, Wheel & Axle Works, Catasauqua, Pa., for Fuller-Lehigh pulverizer mills for their two thousand barrel cement plant being erected at Harvey, Iowa. These mills will be used in coal, raw material and clinker departments.

—In order to provide for the very heavy demand for Edison lamps, and to take care of the new developments in Gem, Tantalum and Tungsten lamps, the General Electric Co. have in the past year built four new factories at East Boston, Toledo, O., Fort Wayne, Ind., and Newark, N. J.

—The Ohio Blower Co., Cleveland, has upon the press a comprehensive catalogue which bids fair to excel anything in its particular line—that of centrifugal steam and oil separators, cast iron exhaust heads and gravity closing ventilators. Requests which are sent in now will be honored just as soon as the catalogue is ready for distribution.

—The Massachusetts Fan Co., Watertown, Mass., is furnishing an equipment of special mitre-type tempering and reheating coils to be used in connection with a fan system of ventilating and heating at the Boston City Hospital. The First International School at Cincinnati is being equipped by the same company with a special steel plate motor driven ventilating fan.

—Williams, Brown & Earle, Philadelphia, are installing, for the United States Government in the Bureau of Forestry, Washington, D. C., one of their new complete perfecting blue printing, washing and drying machines. This machine is arranged not only to make the blue prints, potash, and dry them, but also is arranged to make, develop and dry, sepia prints on the same machine.

—A. P. Witteman & Co., eastern sales agents for the Cyclops Steel Works, makers of sigh-speed steel and tool steels, also sales agents for the Chester Forging & Engineering Co., are removing their offices to more commodious and extensive quarters on the twelfth floor of the Fidelity Mutual Life Bldg., Broad Street, Philadelphia. Their stock will be carried at Nos. 233-237 Cherry Street, Philadelphia.

—Buffalo Steam Pump Co., Buffalo, have been awarded the contract on bids received by the Department of the Interior, U. S. Reclamation Service, at their office in the Federal Building, Chicago, for electrically driven pumps in connection with the irrigating work known as the Garden City Project at Deerfield, Kans. The contract covers a number of vertical shafts and centrifugal pumps with direct connected induction motors.

—The General Electric Co., Schenectady, is furnishing the entire electrical equipment for the Tajo mines in the Rosario district of Mexico. The order includes a three-phase, 60-cycle, 2300-volt revolving field generator of 150 kilowatts capacity, 9 oil cooled type H transformers, three 440-volt, form K, induction motors of 15, 35 and 75 horsepower capacity with starting compensators, 2-circuit feeder panel, complete lighting arrester equipment and the necessary supplies of wire, insulators, etc.

—At a meeting of the stockholders of the Eureka Fire Hose Co., it was unanimously adopted to change the corporate number of the company to Eureka Fire Hose Manufacturing Co., and the following directors were elected for the ensuing year: B. L. Stowe, N. F. McKeon and G. A. Wies. Other officers for the year are: B. L. Stowe, president; I. B. Markey, vice-president; G. A. Wies, vice-president and treasurer; N. F. McKeon, secretary; W. F. Wies, assistant secretary and W. F. Volz, assistant secretary.

—The Robins New Conveyor Company, which has been recently incorporated, will be operated under the management of Thomas Robins, who founded the Robins Conveying Belt Co. in 1896 and was president of that concern until March, 1907, when its management passed into other hands. The position of chief engineer in the new company is filled by C. Kemble

Baldwin, who has served in the Robins Conveying Belt Co. in the same capacity for the last seven years. The offices of the company are at 38 Wall Street, New York, and 1240 Old Colony Building, Chicago.

—Some time ago the Massachusetts Fan Co., Watertown, Mass., began the use of ball bearings upon their large fans. Friction was thereby materially reduced and the pollution of the air by the oil escaping from bearings avoided. This company is about ready to place upon the market a complete line of smaller steel plate fans equipped with ball-bearings. The success of these fans will mark a distinct advance in fan blower practice, for both personal attention and the continuous use of oil will be avoided, while the power required will be materially reduced.

—The G. Drouve Co., Bridgeport, at the annual meeting of their directors, held February 3, 1908, elected G. Drouve as president and treasurer and William V. Dee secretary of the company. Mr. Dee, who recently resigned from *The Railway Age* to take an interest in the company, has been appointed general sales manager. The company manufactures the "anti-pluvius" skylight, of which 125,000 square feet has been installed on the Hoboken terminal of the Delaware, Lackawanna and Western Railroad and the Lowell window operating device now used in the shops of the N. Y. C. & H. R. R. R., Harmon, N. Y., the Delaware, Lackawanna and Western Railroad Co., Scranton, Pa.

—The *General Electric Review*, published by the General Electric Co., Schenectady, for February contains the following articles: Lord Kelvin; A Gas-Electric Car for Railway Service, by John R. Hewett; Electro-Metallurgy of Iron and Steel, Part I, by Samuel A. Tucker; Illumination of Niagara Falls, by W. D'A. Ryan; Notes on the Determination of Railway Power Station Capacities, Part II, by E. E. Kimball; Covington Coke Extractor, by M. R. Clark; The Rotary Converter, Part II, by E. J. Berg; Some Notes on Wiring and Wiring Supplies for Mining Service, Part I, by F. A. Barron; Motor Driven Drainage Pump; Luminous Arc Headlight, by G. N. Chamberlin; The "Invincible" Renovator, by Thomas Raddin; A Motor Driven Laundry, by L. E. Smith; A Model Small Isolated Plant, by Edward E. Peasley, and notes.

—The Power Specialty Co., 111 Broadway, New York, manufacturers of the Foster patent steam superheater, has secured among recent contracts the following covering installation of this superheater in the boilers indicated: Home Electric Light & Steam Heating Co., Tyrone, Pa., 840 H. P. in Stirling boilers; Torresdale Filtration Plant, Philadelphia, 900 H. P. in Heine boilers; Western Clock Manufacturing Co., La Salle, Ills., 300 H. P. in return tubular boilers; Bernheimer & Schwartz Brewing Co., New York, 1990 H. P. in Heine boilers; Garden City Co., Garden City, L. I., 200 H. P. in return tubular boilers; and National Sugar Refining Co., Yonkers, N. Y., 1134 H. P. in B. & W. boilers. They have also sold Foster superheaters of the independently fired type to New Jersey Zinc Co., University of West Virginia, Abendroth & Root Manufacturing Co., and Seacoast Canning Co.

NEW CATALOGUES AND TRADE PUBLICATIONS

NOTE.—The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page 11.

Arch and Wall Blocks.

HENRY MAURER & SON, 420 E. 23rd St., New York.—Well-printed catalogue illustrated and descriptive of arch and wall blocks. Also contains many views of buildings on which these blocks have been used, together with testimonial letters. 6 by 9 in.; pp. 54.

Cars.

KILGORE-PETSLER CO., Minneapolis.—Catalogue devoted to an illustrated description of industrial and mine cars and narrow gauge industrial railways. 6 by 9 in.; pp. 56.

Drawing Instruments.

THEO. ALTENEDER & SONS, Philadelphia.—Catalogue and price list illustrating and describing a full line of drawing instruments. 5 by 8 in.; pp. 110.

Electric Fans.

ROBBINS & MYERS CO., Springfield, Ohio.—Bulletin No. 36 illustrating and describing direct and alternating current ceiling, bracket and desk fans. 8 by 7 in.; pp. 16.

Electrical Equipment.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Bulletins Nos. 4544, 4558, 4563 and 4564 illustrate and describe continuous current railway switchboards; isolated plant switchboard panels with circuit breakers; electric switch indicators and centrifugal air compressors for industrial air blast and exhauster service respectively. 8 by 10½ in.

Fittings and Flanges.

TIGHT JOINT CO., 306 E. 47th St., New York. Price list containing a brief illustrated description of high pressure hydraulic fittings and flanges for all pressures up to 5,000 pounds. 3½ by 6 in.; pp. 20.

Gate Valves.

JENKINS BROS., 71 John St., New York.—Supplement to the 1907 catalogue illustrating and describing extra heavy gate valves for 250 pounds working pressure and medium pressure gate valves for 150 pounds working pressure. 6 by 9 in.; pp. 12.

Graphite Brushes.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J.—Booklet treating of graphite brushes. Also contains much useful information for users of graphite brushes, and this same information is also of interest to others connected with mechanical and electrical pursuits. 3½ by 6 in.; pp. 12.

Hoisting Drums.

THE HAYWARD CO., 97 Cedar St., New York.—Booklet illustrating the application of the Hayward "Two in One" hoisting drum to several classes of machines. 5½ by 8½ in.; pp. 16.

Locomotives.

LIMA LOCOMOTIVE & MACHINE CO., Lima, O.—Catalogue No. 15 describes Shay geared and rod locomotives. Contains many views showing locomotives in operation. The catalogue is well printed in two colors. 6 by 9 in.; pp. 80.

Machine Tools.

NEWTON MACHINE TOOL WORKS, Philadelphia.—Cloth-bound catalogue illustrating and briefly describing boring machines, cold saw cutting off machines, crank planers, drilling machines, gear cutting machines, milling machines, nut machines, rotary planing machines, shapers, and slotting machines, together with tables giving dimensions. 6 by 9 in.; pp. 302.

Miners' Lamps.

JOHN DAVIS & SON, 110 West Fayette St., Baltimore.—Catalogue illustrating and describing miners' safety lamps, together with prices. 5½ by 8½ in.; pp. 16.

Pyrometers.

WILLIAM H. BRISTOL, 45 Vesey St., New York.—Catalogue No. 20 treats of electric pyrometers for blast furnaces and indicating recording and combination outfits. Fully illustrated. Also contains prices, together with a partial list of users and many testimonial letters. 9 by 12 in.; pp. 16. Also Bulletin No. 24 illustrates and describes smoked chart recorders that are sensitive, accurate and of simple construction.

Roller Bearings.

HYATT ROLLER BEARING CO., Newark.—Bulletin No. 103 gives data showing friction load of shafting in an electrically driven machine shop when equipped with Hyatt roller bearings, from official tests made at Buffalo, Rochester and Pittsburg Railway, Du Bois, Pa. 6 by 9 in.; pp. 4.

Shears.

UNITED ENGINEERING & FOUNDRY CO., Pittsburg.—Well printed catalogue illustrating and describing lever and vertical shears. Also contains a partial list of users. 10 by 8½ in.; pp. 74.

Spiral Riveted Pipe.

AMERICAN SPIRAL PIPE WORKS, Chicago.—Circular No. 21 E. M. illustrates and describes some of the varied uses and many of the advantages of spiral riveted pipe and forged steel flanges. 8 by 10 in.; pp. 16.

Springs.

STANDARD STEEL WORKS, Harrison Bldg., Philadelphia.—Catalogue illustrating and describing steel springs for railway and electric traction service. 9 by 6 in.; pp. 36.

Steam Specialties.

AMERICAN STEAM GAUGE & VALVE MFG. CO., 208 Camden St., Boston.—Cloth-bound catalogue illustrating and describing gauges, valves, indicators and kindred appliances for governing, indicating, measuring, recording, and controlling steam, water, air, gas, oil, ammonia and all other pressures. Also contains tables giving sizes, prices, etc. Fully indexed. 6 by 9 in.; pp. 246.

Steam Traps.

JOHN T. LUNDSTROM, 218 South 3rd St., Allentown, Pa.—Catalogue and price list illustrating and describing Corliss valve steam traps, together with tables giving prices, dimensions, weights, etc. Also a pamphlet treating of the Lundstrom superheater steam separator. 3 by 6 in.; pp. 4.

Steam Turbine Machinery.

DE LAVAL STEAM TURBINE CO., Trenton, N. J.—Bulletin No. 501 briefly describing different types of turbine and motor-driven machinery. Illustrated. 7 by 4½ in.; pp. 30.

Steam Turbines.

TERRY STEAM TURBINE CO., Hartford, Conn.—Catalogue devoted to an illustrated description of steam turbines for use either belted to shafting or machine or direct connected to dynamo, pumps and blowers. 6 by 9 in.; pp. 12.

Steel Shelving.

MERRITT & CO., 1020 Ridge Ave., Philadelphia.—Folder devoted to describing adjustable and flexible steel shelving, showing many illustrations of the various arrangements of shelving—some with roller shelves, some with drawers, some with doors on the front, etc., suiting it to various uses. This shelving is also made non-adjustable. 6 by 5½ in.; pp. 12.

Stokers.

UNDER-FEED STOKER CO. OF AMERICA, Marquette Bldg., Chicago.—Booklet describing how the smoke nuisance is abated in the Jones under-feed stoker. Also contains many views of buildings in which this stoker has been installed, together with testimonial letters from users. 6 by 9 in.; pp. 24.

Switch-Board Instruments.

WESTON ELECTRICAL INSTRUMENT CO., Waverly Park, Newark, N. J.—Two circulars devoted to an illustrated description of alternating current and direct current switchboard voltmeters and ammeters. Also gives prices.

Taps.

A. J. SMART MFG. CO., Greenfield, Mass.—Catalogue illustrating and describing hand, screw, nut, plate, bolt, tapper and pulley taps, together with prices, dimensions, etc. 4½ by 7 in.; pp. 46.

Time Recording.

CALCULAGRAPH CO., 9-13 Maiden Lane, New York.—Booklet containing an excellent article by Robert W. Higgins, the expert accountant for nine years in charge of the cost and estimate department of the Gorham Co. Embodies a very clear discussion of the elements of cost and the distribution of the factory burden, and describes a new and interesting method of taking job times by the use of an annunciator system, in connection with the Calculagroph operated by a clerk at a central or separate office. 8¾ by 5½ in.; pp. 10.

Water Level Gauge.

BRISTOL CO., Waterbury, Conn.—Bulletin No. 69 describes recording water level gauges for automatically recording depths of water over weirs, heights of tides, water in tanks, reservoirs, canals, sewers, etc. Also the rate of flow over weirs, volumes in tanks, etc. Illustrated. 8 by 11 in.; pp. 12.

Windmills.

FLINT & WALLING MFG. CO., Kendallville, Ind.—Catalogue No. 54 illustrative and descriptive of windmills, towers, tanks, pumps and auxiliary goods. Contains tables giving capacities, sizes, prices, etc. Catalogue is cloth bound and fully indexed. 6 by 9 in.; pp. 250.

CLASSIFIED ADVERTISING SECTION

Rate, three cents a word per month. Minimum charge $1.00 per month. No electrotypes or illustrations; no display type. Cash with order. Forms close 20th of the month preceding date of issue.

Box numbers may be used and we will forward all replies. We will not give information about any advertiser using a box number. Correspondents answering advertisements may specify that their replies shall not be forwarded to certain persons or firms—thus avoiding possible embarrassment. Original letters of reference, etc., should not be sent to unknown correspondents; copies will serve the same purpose.

HELP WANTED

WANTED: Reliable and successful oil filter salesman. Address Box 109, care of THE ENGINEERING MAGAZINE, 140 Nassau St., New York. 1-3

TEACHERS: Instructor in metallurgy for western school, $1,200; good opening for instructor in Forestry, $900 to start; professor of Mining Engineering, $1,800; professor of Civil Engineering, $1,200; professor of Electrical Engineering, $1,300; other good openings for technical teachers. HAPGOODS, 305 Broadway, N. Y. 12-6

SALESMAN FOR MECHANICAL STOKERS. Excellent opportunity in New York City territory for a salesman for a very well-known and highly successful mechanical stoker. Applicant need not necessarily be an Engineer, but must understand power plants and be particularly familiar with modern steam boiler equipments. Only a man of marked capacity in salesmanship will be accepted. Write, stating age and past experience fully, and appointment will be given. Address, G. P. H., care of THE ENGINEERING MAGAZINE, 140 Nassau St., New York. 1-3

SITUATIONS WANTED

POSITION AS MANAGER wanted by a young man 36 years of age, with 18 years' experience in machine shop, iron and brass foundry, blacksmith, pattern and wood-working shop practice. Able economist, executor, accountant and systematizer. At present engaged. Box 110, care of THE ENGINEERING MAGAZINE, 140-142 Nassau St., New York. 1-3

AUTOMOBILES

"SUCCESS" AUTOMOBILE $250. The original motor-buggy. After eleven years labor by an engineer a perfect steel tired Auto. Runs 25 miles an hour, good hill climber. Write for particulars. SUCCESS AUTO-BUGGY MFG. CO., Inc., 522 De Baliviere Ave., St. Louis, Mo. 12-6

BOOKS

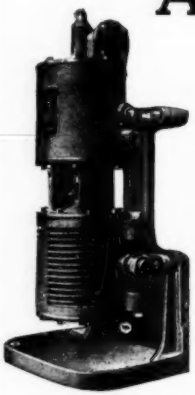
THE FACTORY MANAGER tells how to eliminate dead expense; unnecessary fixed charges; friction and delays; useless men, methods and records; unnecessary time and material; interruptions, "waits," and guess-work; too many handlings of work, etc., and how to arrive at exact cost of work done. Send for circular. THE ENGINEERING MAGAZINE, 140-142 Nassau St., New York.

EVERY PRACTICAL ENGINEER should compile his own note book. Subscribe for Webber's tables, printed on 4x7" sheets, for insert binders. Every engineering subject, 25 cts. per sheet, printed on both sides. Write for information to WILLIAM O. WEBBER, Consulting Engineer, 432 Exchange Building, Boston, Mass. 9-5

THE ENGINEERING INDEX ANNUAL for 1906 embraces all branches of engineering, and clearly indexes alphabetically by subject about 7,000 important articles of permanent value which appeared during 1906 in about 250 engineering journals, transactions and proceedings. Complete in itself for the period covered. We undertake to supply the full text of every article indexed, in the original language, together with all accompanying illustrations. 416 pages, 9½ by 7 inches, cloth binding; $2.00 prepaid. Sent on approval. THE ENGINEERING MAGAZINE, 140-142 Nassau St., New York.

Westinghouse

Air Compressors



Anyone Interested

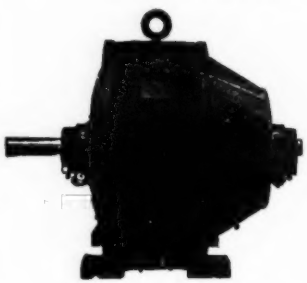
in the subject of compressed air, and what it can do, will be furnished upon application to our nearest office with our latest catalogue on air compressors; steam, — motor, — and belt-driven, with recommendations as to the selection of a compressor best suited to the conditions in question.

The Westinghouse Air Brake Co., Pittsburg, Pa.

New York, Trinity Building — Chicago, Railway Exchange Building — St. Louis, 1932 North Broadway

For Canada, Canadian Westinghouse Co., Ltd., Hamilton, Ontario

Individual-Motor Drive



With higher speeds and increased demands, the problem of transmitting electric power economically is an important one. The use of shafting and belting soon becomes too wasteful and costly. The logical solution is to introduce individual-motor drive, which reduces the loss of power in transmission to a minimum.

Our Booklet "Your Power Problem," sent upon application

Westinghouse Electric & Mfg. Co.

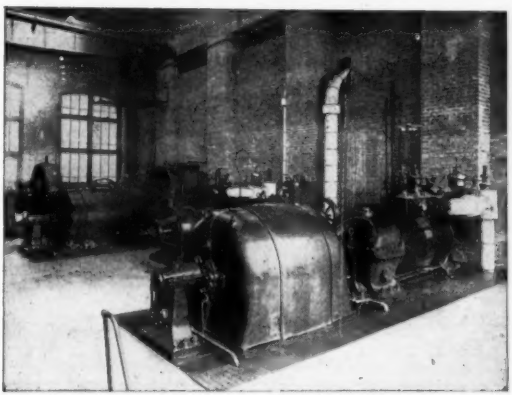
Atlanta, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Los Angeles, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, St. Louis, Salt Lake City, San Francisco, Seattle, Syracuse

Canada: Canadian Westinghouse Co., Ltd., Hamilton, Ontario. Mexico: G. & O. Braniff & Co., City of Mexico

Westinghouse

Steam Turbines

can always be relied upon in emergencies.



The day after a 3,000 K. W. Westinghouse Turbine was installed in a plant already equipped with two turbines of another make, one of the latter failed, and the Westinghouse unit was immediately started and called upon to carry loads up to 3,200 K. W. during peak hours, without the assistance of the condenser, which had not then been installed. In spite of this handicap the Westinghouse Turbine met the emergency without difficulty.

Full particulars of Westinghouse Turbines in Catalogue 7002.

The Westinghouse Machine Company

Steam Engines, Steam Turbines, Gas Engines, Gas Producers, Storage Batteries and the Roney Stoker.

New York, 10 Bridge St.
Boston, 131 State St.
Cleveland, New England Bldg.
Chicago, 171 La Salle St.
Cincinnati, Traction Bldg.
Atlanta, Candler Bldg.
Pittsburg, Westinghouse Bldg.
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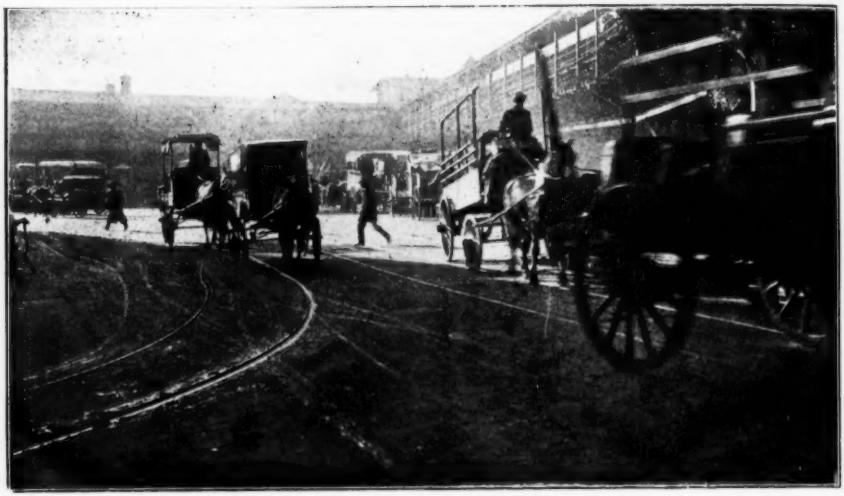

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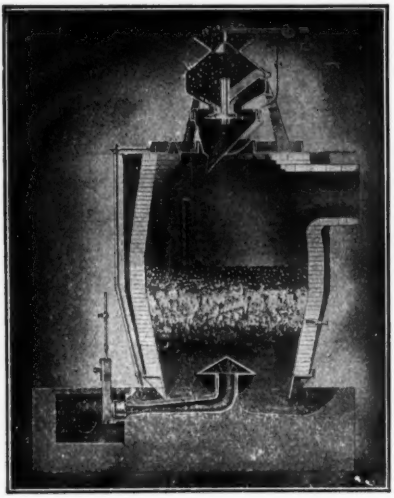

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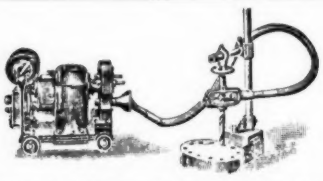

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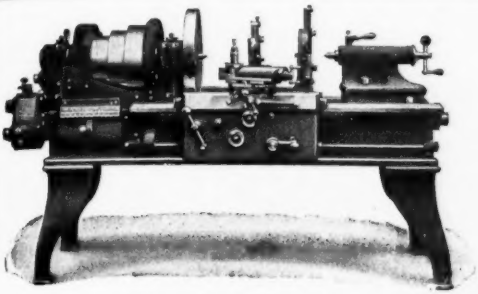

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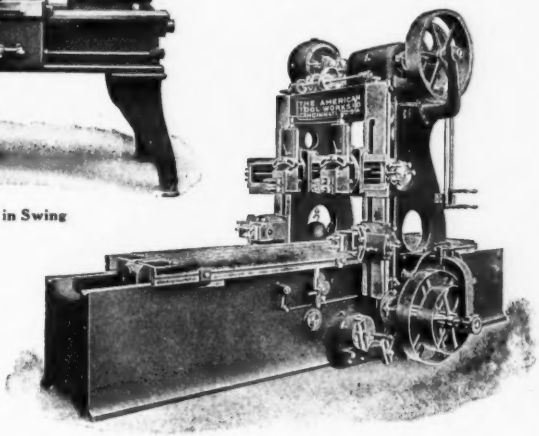

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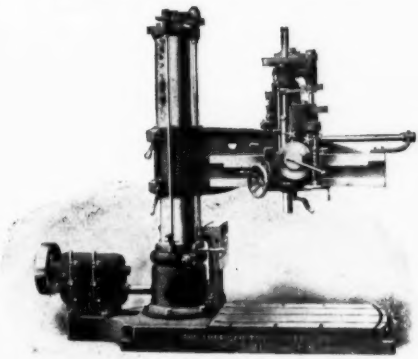

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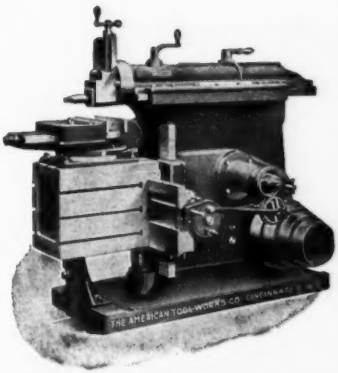

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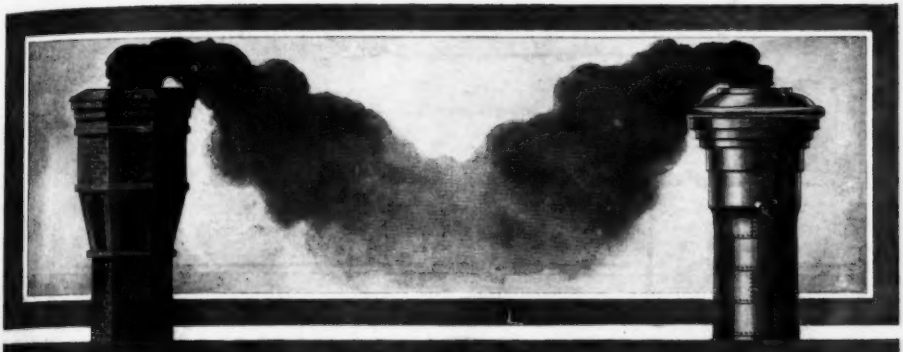

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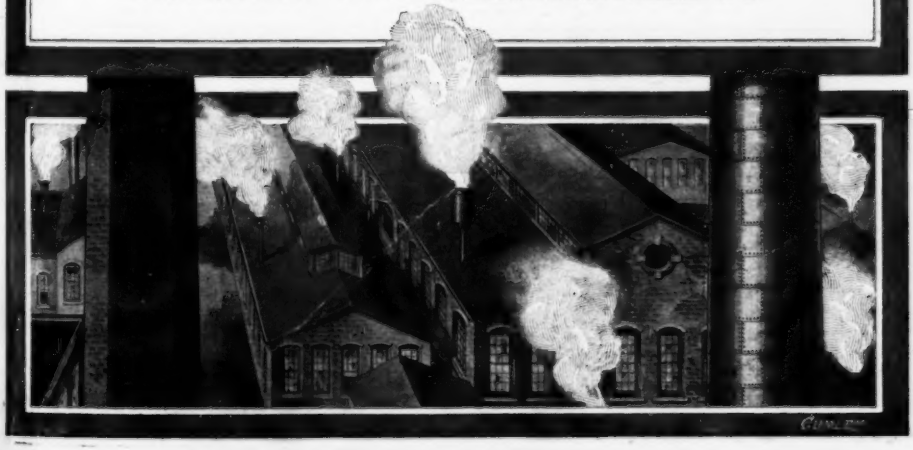

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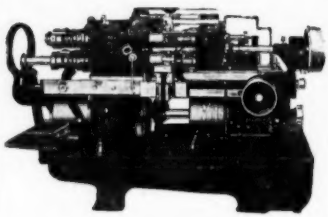

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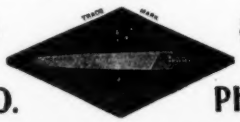

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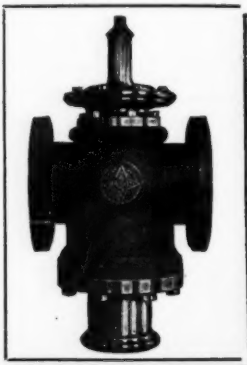

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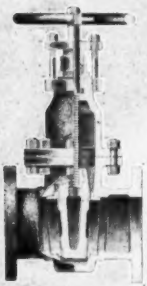

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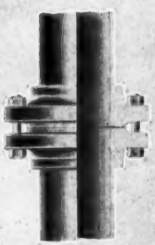

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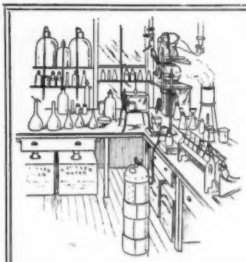

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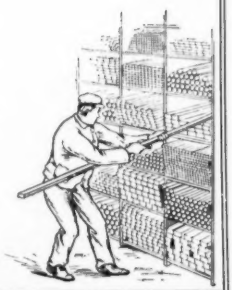

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AUTHORS AND PAPERS FOR MARCH, 1908.

EDWIN C. ECKEL *(Conditions and Prospects in the American Iron Industry)*—Born New York City, 1875; graduated (C. E.) New York University, 1896; 1895-1898, field work in surveying and masonry construction; 1899-1901, assistant N. Y. State Geological Survey; 1901-1905, assistant geologist U. S. Geological Survey; 1906-1907, geologist in charge of investigations of iron ores and structural materials; resigned from U. S. Geological Survey in 1907 to take up private practice as consulting engineer and geologist on matters relative to iron ores and cement materials. Author of "Cements, Limes and Plasters," "Cement Materials and Cement Industries of the U. S.," and of many papers on engineering and economic geology; associate, American Society of Civil Engineers; member, Society of Chemical Industry; fellow, Geological Society of America.

H. M. WHARTON *(The Production System of the Westinghouse Electric & Manufacturing Co.)*—Born Malden, Mass.; educated at Sibley College of Mechanical Engineering, Cornell University; employed in various capacities by the Westinghouse Electric & Mfg. Co. from 1893 to 1905, being assistant superintendent in charge of production from 1898 to 1902 (with one year's work in the same department preceding, from 1896 to 1897) and engineer of works from 1902 to 1905; in the spring of 1905 went to Milwaukee as assistant to the general superintendent of the Allis-Chalmers Co., to superintend the erection of the new shops of that company at West Allis; in 1906 joined in organizing the Land-Wharton Co., to undertake the design and construction of power and manufacturing plants.

PERCIVAL ROBERT MOSES *(Power Equipment for the Small Factory)*—Born in New York; educated in Europe and in the United States; entered the School of Mines of Columbia College in 1891 and graduated in 1895-6 with the degree of Electrical Engineer; was for some time with the Sprague Electrical Company in factory and construction work; practising as consulting engineer in New York since 1898; member of the American Institute of Electrical Engineers.

J. C. WM. GRETH *(Water for Economical Steam Generation)*—Graduated Cornell University (M. E.), 1897; immediately took up steam power-plant work and is licensed engineer for the city of Buffalo, N. Y., for operating steam plants of any power; later was connected with Frick Co. of Waynesboro, Pa., for several years, superintending the erection of steam boilers, Corliss engines, refrigerating and ice-making plants; since 1891, as manager of the water-purifying department of Wm. B. Scaife & Sons Co., has made a special study of water softening and purification for boiler feed and all industrial uses, giving his whole attention to the designing, manufacturing and operation of water-softening and purifying system; member of the American Chemical Society and the Engineers' Society of Western Pennsylvania.

SIDNEY A. REEVE *(Feed-Water Heating for the Power Plant)*—For years professor of steam engineering at the Worcester Polytechnic Institute; now practising as consulting engineer in New Haven, Conn.; well known for his researches in thermodynamics and in the design of internal-combustion motors. Professor Reeve has been actively engaged in experimental work in connection with motors utilizing the principle of controlled combustion and in the solution of the problem of a successful gas turbine. Author of a treatise on the thermodynamics of heat engines and of a volume of steam tables; member of the American Society of Mechanical Engineers.

REGINALD PELHAM BOLTON *(The Argument for the Open Feed Heater)*—Born and apprenticed in England; served as assistant engineer at the Edgemoor Iron Works and as assistant to Dr. Erasmus Leavitt; has been in practice in New York City since 1895 on the equipment of large buildings, having designed, within the last few years, the equipment of the Bowling Green offices, the Grand Central Station, the Royalton and Lorraine hotels. He originated the vertical system of electric wiring and duplex-pressure hydraulic elevator system; has been in charge of the remodeling of the Ridgewood Pump-

ing Station for the city of Brooklyn, before and since its incorporation with the city of New York, from 1896 to 1900; associate member of the Institution of Civil Engineers, and member of the American Society of Mechanical Engineers.

GEORGE F. STRATTON *(Labor-Cost Distribution at the General Electric Shops)*—For thirty years connected with manufacturing corporations in various capacities, in the factory, the office, and on the road. For ten years past has been with the General Electric Co. at their Lynn works, where 10,000 hands are employed. His intimate acquaintance with engineers and officials has thus afforded him ample opportunities for observing the working of one of the greatest of American machine shops.

WERNER BOECKLIN *(Economical Material-Handling Equipments for Industrial Plants)*—Graduated 1891 from the School of Mines, Columbia University, with the degree of Civil Engineer; was engaged with Heyl & Patterson, Robins Conveying Belt Co., and John A. Mead & Co. as engineer in charge of the design of a number of important material-handling equipments, and with W. S. Barstow & Co., as engineer in charge of erection of a large steel-car plant and other works; at present associated with Percival Robert Moses as consulting engineer; member of the American Society of Civil Engineers and of the New York Railroad Club.

T. KENNARD THOMSON *(Hoisting Machinery for the Handling of Materials)*—A specialist of ten years' experience in structural steel work and ten years in foundation work; has been bridge engineer for a railroad, chief engineer of a bridge company, and for eight years chief engineer for large contractors in addition to much consulting practice; he was retained on many New York sky-scrapers, including the Commercial Cable Building, Mutual Life, Manhattan Life addition, Trinity, U. S. Realty, City Investing and the forty-one-story Singer Building, and has designed many caissons. Member A. S. C. E., C. S. C. E., A. S. M. E., etc.

P. J. DARLINGTON *(Fundamental Principles of Works Organization and Management)*—Born in Philadelphia, 1869; educated at Pennsylvania State College and at Sibley College, Cornell University; engaged at William Sellers & Co.'s, Philadelphia, in connection with the erection of large gun lathes for the Washington Navy Yard, also at Bement, Miles & Co.'s, Phiadelphia, upon construction of heavy shipbuilding equipment for the Newport News Company; subsequently in the drawing room of William Cramp & Sons' Company, working upon details of engines for the St. Paul and St. Louis; engineer's clerk on the International Navigation Company to study the performance of modern marine equipment, including quadruple-expansion engines, high-pressure boilers, forced-draft and modern auxiliary machinery; superintendent of the Royal Electric Company, of Montreal, in which capacity he had charge of the completion and installation of the generators of the Chambly Manufacturing Company; has had widely extended opportunities of studying shop systems, both from the workman's and employer's standpoint.

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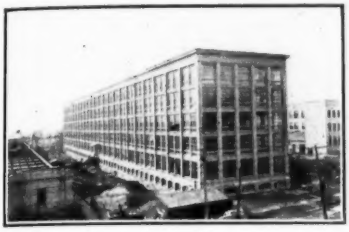

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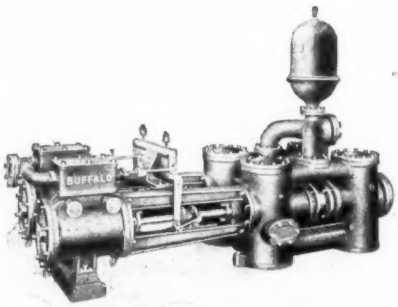

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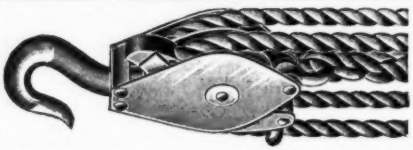

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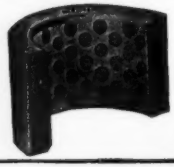

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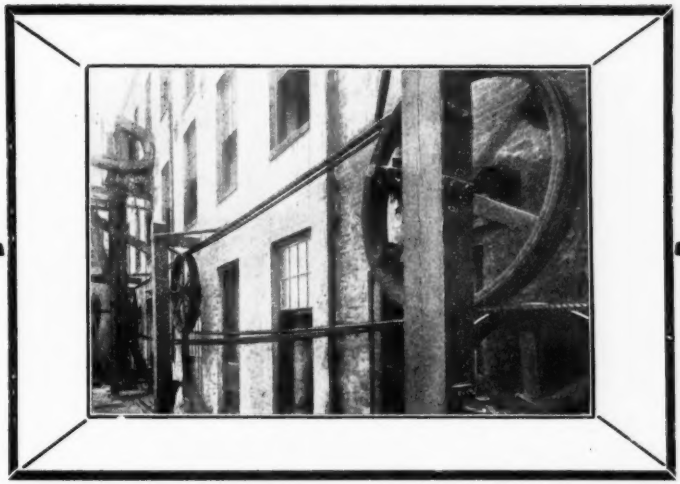

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Air Separating Machinery.
Raymond Bros. Impact Pulverizer Co., Chicago.

Air Washers & Humidifiers.
Buffalo Forge Co., Buffalo.

Alarms, High and Low.
Wright Mfg. Co., Detroit.

Ammeters.
Bristol Co., Waterbury, Conn.
Bristol, Wm. H., New York.
Western Electric Co., Chicago.
Weston Elec. Inst. Co., Waverly Pk., Newark, N. J.

Annunciators.
Ostrander & Co., W. R., New York.
Western Electric Co., Chicago.

Anti-Friction Bearings.
Chapman Ball Bearing Co., Boston.

Anti-Friction Metals.
Phosphor Bronze Smelting Co., Phila.
Poole Eng. & Mch. Co., Baltimore.

Architects.
Collins, D. C. Newman, New York.

Assay Furnaces.
Hoskins Co., Chicago.

Automatic Conveyors.
Lamson Consolidated S. S. Co., Boston.

Automatic Governors for Air Compressors.
Westinghouse Air Brake Co., Pittsburg.

Automatic Grab Buckets.
Hayward Co., New York.
Mead-Morrison Mfg. Co., Boston.
National Equipment Co., Chicago.

Automatic Weighing Machines.
Automatic Weighing Machine Co., Newark.

Automobile Drop Forgings.
Chicago Drop Forge & Foundry Co., Kensington, Ill.

Automobile Parts.
Whitlock Coil Pipe Co., Hartford.

Ballast Unloaders.
Marion Steam Shovel Co., Marion, O.

Ball Bearings.
American Ball Co., Providence.
Chapman Ball Bearing Co., Boston.

Band Saws.
Fay & Egan Co., Cincinnati.

Balanced Valve.
Mason Regulator Co., Boston.

Bearing Metal.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Bearings, Roller.
Hyatt Roller Bearing Co., Newark.

Belt Conveyors.
Beaumont Co., R. H., Philadelphia.
Jeffrey Mfg. Co., Columbus.
Caldwell & Son Co., H. W., Chicago.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Webster Mfg. Co., Chicago.

Belt Dressing (Waterproof).
Dixon Crucible Co., Jos., Jersey City.

Belt Shifters.
Mason Regulator Co., Boston.

Belting.
Boston Belting Co., Boston.
Eureka Fire Hose Mfg. Co., N. Y.
Jeffrey Mfg. Co., Columbus.
Link-Belt Co., Chicago.

Belt Lacing.
Bristol Co., Waterbury, Conn.
Robins Conveying Belt Co., N. Y.

Bending Rolls.
Niles-Bement-Pond Co., New York.
Sellers Co., Inc., William, Phila.

Binding Devices.
Baker-Vawter Co., Chicago.

Bins & Racks, Steel.
Merritt & Co., Philadelphia.

Blast Furnaces.
Kennedy, Walter, Pittsburg.
McClure, Son & Co., G. W., Pittsburg.
Riter-Conley Mfg. Co., Pittsburg.
Tippett & Wood, Phillipsburg, N. J.

Blocks, Tackle.
Lane Bros. Co., Poughkeepsie, N. Y.
National Equipment Co., Chicago.

Blowers.
American Blower Co., Detroit.
American Gas Furnace Co., N. Y.
Buffalo Forge Co., Buffalo.
Crocker-Wheeler Co., Ampere, N. J.
Exeter Machine Wks., Exeter, N. H.
Green Fuel Economizer Co., Matteawan, N. Y.
Massachusetts Fan Co., Watertown, Mass.
Ohio Blower Co., Cleveland.
Sirocco Engineering Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago.
Wing Mfg. Co., L. J., New York.

Blow Pipes.
Hoskins Co., Chicago.

Blowers, Turbine.
De Laval Stm. Turbine Co., Trenton.
Wing Mfg. Co., L. J., New York.

Blue Prints.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.

Blue Print Filing Cabinets.
Kolesch & Co., New York.

Blue Print Frames.
Kolesch & Co., New York.

Blue Print Machinery.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.
Pense Blue Print Machinery & Supply Co., C. F., Chicago.
Revolute Machine Co., New York.
Williams, Brown & Earle, Philadelphia.

Boiler Door Arches.
McLeod & Henry Co., Troy, N. Y.

Boiler Feeds.
Keyes & Son, F. E., New York.

Boiler Feeders.
Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.

Boiler Fronts and Fittings.
Amer. Steam Gauge & Valve Mfg. Co., Boston.

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Continental Iron Wks., Brooklyn.
Lunkenheimer Co., Cincinnati.
McLeod & Henry Co., Troy, N. Y.
Mecklenburg Iron Works, Charlotte, N. C.
Powell Co., Wm., Cincinnati.
Walworth Mfg. Co., Boston.
Williams Valve Co., D. T., Cincinnati.

Boiler Inspection and Insurance.
Fidelity & Casualty Co., New York.

Boilers.
Abendroth & Root Mfg. Co., Newburgh, N. Y.
Atlantic Works, East Boston, Mass.
Babcock & Wilcox Co., New York.
Chandler & Taylor Co., Indianapolis.
Harrison Safety Boiler Wks., Phila.
Heine Safety Boiler Co., St. Louis.
Kingsford Foundry & Machine Wks., Oswego, N. Y.
Lake Erie Boiler Works, Buffalo.
Morris Co., I. P., Philadelphia.
Oil Well Supply Co., Oswego, N. Y.
Olney & Warrin, New York.
Riter-Conley Mfg. Co., Pittsburg.
Robb-Mumford Boiler Co., So. Framingham, Mass.
Smith & Son Co., Sam'l, Paterson, Struthers, Wells & Co., Warren, Pa.
Tippett & Wood, Philipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.

Bolt and Nut Machinery.
Niles-Bement-Pond Co., New York.

Books, Scientific.
Baird & Co., Henry Carey, Phila.

Boosters.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Western Electric Co., Chicago.

Boring Mills.
Niles-Bement-Pond Co., New York.
Sellers Co., William, Inc., Phila.

Brakes—Friction.
Elec. Controller & Supply Co., Cleveland.

Brass Founders' Supplies.
Blake Mfg. Co., Geo. F., New York.
Obermayer Co., S., Cincinnati.

Brass Makers' Lathes.
Am. Tool & Machine Co., Boston.
Niles-Bement-Pond Co., New York.

Breast Drill, Electric.
Clark, Jas., Jr., Elec. Co., Inc., Louisville.

Brick.
Maurer & Son, Henry, New York.

Brick and Tile Machinery.
American Blower Co., Detroit.
Jeffrey Mfg. Co., Columbus.

Bridges, Roofs, Etc.
Berlin Const'n Co., Berlin, Conn.
Brown Hoisting Mchy. Co., Cleveland.
Interstate Engineering Co., Cleveland.
Riter-Conley Mfg. Co., Pittsburg.
Scherzer Rolling Lift Bridge Co., Chicago.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.

Bronze Bearings.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Bronze Bushings.
Graphite Lubricating Co., Bound Brook, N. J.

Bronze Castings.
D'Este Co., Julian, Boston.
Morris Co., I. P., Philadelphia.

Bucket Elevators.
Caldwell & Son Co., H. W., Chicago.
Hayward Co., The, New York.
Jeffrey Mfg. Co., Columbus.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Webster Mfg. Co., Chicago.

Buckets—Dredging & Excavating.
Hayward Co., New York.

Building Materials.
Lawrence Cement Co., New York.

Buildings, Iron, Steel and Steel Concrete.
Berlin Constr'n Co., Berlin, Conn.
Brown Hoisting Mchy. Co., Cleveland.
Link Belt Co., Philadelphia.
Interstate Engineering Co., Cleveland.
Riter-Conley Mfg. Co., Pittsburg.
Stone & Webster Engineering Corp., Boston.
Turner Construction Co., New York.

Bulldozers.
Niles-Bement-Pond Co., New York.

Bunkers.
Beaumont Co., R. H., Philadelphia.

Bunkers, Coal, Ore, Etc.
Beaumont Co., R. H., Philadelphia.
Berquist, A. Samuel, Brooklyn.

Bushings, Bronze.
No. American Metaline Co., Long Island City.

Bushings—Bronze & Graphite.
Graphite Lubricating Co., Bound Brook, N. J.

Business Systems.
Baker-Vawter Co., Chicago.
Cooper & Co., John A., Chicago.
Gunn, Richards & Co., New York.
Wehner, P. E., Cincinnati.
Williams & Staff, Stephen T., N. Y.

Cable-Railway Machinery.
Mead-Morrison Mfg. Co., Boston.
Poole Eng'g & Mch. Co., Baltimore.
Robins Conveying Belt Co., N. Y.

Cables, Elec. & Submarine.
General Electric Co., New York.
Western Electric Co., Chicago.

Cableways—
(See Aerial Tramways.)

Cables, Wire.
Lidgerwood Mfg. Co., New York.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Calculating Machines.
Calculagraph Co., New York.
Felt & Tarrant Mfg. Co., Chicago.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.

Calorimeters.
Amer. Steam Gauge & Valve Mfg. Co., Boston.

Carbide of Silicon.
Carborundum Co., Niagara Falls, N.Y.

Carborundum.
Carborundum Co., Niagara Falls, N. Y.

Carborundum Paper & Cloth.
Carborundum Co., Niagara Falls, N.Y.

Card Indicators.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Cars.
Browning Eng'g Co., Cleveland.
C. W. Hunt Co., New York.
Koppel Co., Arthur, Pittsburg.
Mead-Morrison Mfg. Co., Boston.
Mecklenburg Iron Works, Charlotte, N. C.

Car Shop Machinery.
Fay & Egan Co., Cincinnati.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Castings, Iron, Steel & Brass.
Buffalo Foundry & Mch. Co., Buffalo.
Caldwell & Son Co., H. W., Chicago.
Curtis & Co. Mfg. Co., St. Louis.
Flagg & Co., Stanley G., Phila.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Jeffrey Mfg. Co., Columbus.
Lake Erie Engineering Wks., Buffalo.
Lunkenheimer Co., Cincinnati.
Lynchburg Foundry Co., Lynchburg, Va.
Mecklenburg Iron Works, Charlotte, N. C.
Moore & Sons Corp., Samuel L., Elizabethport, N. J.
Morris Co., I. P., Philadelphia.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.
Poole Eng'g & Mch. Co., Baltimore.
Powell Co., Wm., Cincinnati.
Riter-Conley Mfg. Co., Pittsburg.
Southwalk Fdy. & Mch. Co., Phila.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia.
Walworth Mfg. Co., Boston.

Cast-Iron Pipe.
Lynchburg Foundry Co., Lynchburg, Va.
U. S. Cast Iron Pipe & Fdy. Co., Phila.
Walworth Mfg. Co., Boston.
Wood & Co., R. D., Phila.

Cement Machinery.
Automatic Weighing Machine Co., Newark.
Bradley Pulverizer Co., Boston.
Caldwell & Sons Co., H. W., Chicago.
Dunning, W. D., Syracuse, N. Y.
Jeffrey Mfg. Co., Columbus.
Lehigh Car Wheel & Axle Works, Catasauqua, Pa.
Mead-Morrison Mfg. Co., Boston.
Raymond Bros. Impact Pulverizer Co., Chicago.
Robins Conveying Belt Co., N. Y.
Ruggles-Coles Eng'g Co., New York.
Smidth & Co., F. L., New York.
Webster Mfg. Co., Chicago.

Cement, Portland.
Alsen's Am. Portland Cement Co., New York.
American Cement Co., Phila.
Atlas Portland Cement Co., N. Y.
Empire Portland Cement Co., Warners, N. Y.
Glens Falls Portland Cement Co., Glens Falls, N. Y.
Lawrence Cement Co., New York.
Lehigh Portland Cement Co., Allentown, Pa.

Chains.
Diamond Chain & Mfg. Co., Indianapolis.
Morse Chain Co., Ithaca, N. Y.

Chain Belting.
Beaumont Co., R. H., Philadelphia.
Caldwell & Sons Co., H. W., Chicago.
Jeffrey Mfg. Co., Columbus.
Link-Belt Eng'g Co., Phila.
Morse Chain Co., Ithaca, N. Y.
Webster Mfg. Co., Chicago.

Chain Conveyors.
Beaumont Co., R. H., Philadelphia.

Chain Joint.
Morse Chain Co., Ithaca, N. Y.

Chain Pipe & Fittings Wrenches.
Williams & Co., J. H., Brooklyn.

Channeling Machines.
Ingersoll-Rand Co., New York.

Checks, Time, Pay & Trade.
Schwerdtle Stamp Co., Bridgeport.

Chemicals.
Roessler & Hasslacher Chem. Co., New York.

Chemists.
Hunt & Co., Robt. W., Chicago.
Lunkenheimer Co., Cincinnati.

Chucks.
Almond Mfg. Co., Brooklyn.
American Tool & Mch. Co., Boston.
Niles-Bement-Pond Co., New York.

Clocks.
Standard Gauge Mfg. Co., Syracuse.

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Clutches, Magnetic.
Cutler-Hammer Mfg. Co., Milwaukee.
Elec. Controller & Supply Co., Cleveland.

Clutch Pulleys.
American Pulley Co., Philadelphia.
Caldwell & Sons Co., H. W., Chicago.
Rockwood Mfg. Co., Indianapolis.

Coal and Ashes-Handling Machinery.
Beaumont Co., R. H., Philadelphia.
Browning Eng'g Co., Cleveland.
Brown Hoisting Mchy. Co., Cleveland.
Caldwell & Sons Co., H. W., Chicago.
Hayward Co., New York.
Hunt Co., C. W., New York.
Interstate Engineering Co., Cleveland.
Jeffrey Mfg. Co., Columbus.
Lidgerwood Mfg. Co., New York.
Link-Belt Eng'g Co., Phila.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Webster Mfg. Co., Chicago.

Coal & Coke Wagons.
Jackson Mfg. Co., Harrisburg, Pa.

Coal Cutters (Air and Electric).
Ingersoll-Rand Co., New York.
Jeffrey Mfg. Co., Columbus.

Coal and Ore Bunkers.
Beaumont Co., R. H., Philadelphia.
Berquist, A. Samuel, Brooklyn.
Morris Co., I. P., Philadelphia.

Coal Weighing Machine, Automatic.
Automatic Weighing Machine Co., Newark.

Coal-Mining Machinery.
Blake Mfg. Co., Geo. F., New York.
General Electric Co., New York.
Hunt Co., C. W., New York.
Ingersoll-Rand Co., New York.
Jeffrey Mfg. Co., Columbus.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Lambert Hoist. Engine Co., Newark.
Link-Belt Eng'g Co., Phila.
McGowan Co., John H., Cincinnati.
Norwalk Iron Wks., So. Norwalk, Ct.
Robins Conveying Belt Co., Passaic, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Coal Screens.
Harrington & King Perforating Co., Chicago.
Jeffrey Mfg. Co., Columbus.
Link-Belt Eng'g Co., Phila.
Ludlow-Saylor Wire Co., St. Louis.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.

Cocks.
Jerguson Mfg. Co., Boston.
Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.
Williams Valve Co., D. T., Cincinnati.
Wright Mfg. Co., Detroit.

Coil Pipe.
National Pipe Bending Co., New Haven.
Whitlock Coil Pipe Co., Hartford.

Comptometers.
Felt & Tarrant Mfg. Co., Chicago.

Concrete Mixers.
Dobbie Foundry & Machine Co., Niagara Falls.
Dunning, W. D., Syracuse, N. Y.
Jeffrey Mfg. Co., Columbus.

Concrete Reinforcing.
Lawrence Cement Co., New York.

Condensers.
Alberger Condenser Co., New York.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., New York.
Epping-Carpenter Co., Pittsburg.
Guild & Garrison, Brooklyn.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., N. Y.
McGowan Co., John H., Cincinnati.
Snow Steam Pump Wks., New York.
Southwark Fdy. & Mch. Co., Phila.
Struthers, Wells & Co., Warren, Pa.
Wheeler Condenser & Eng'g Co., N.Y.
Worthington, Henry R., New York.

Conduit Systems.
Gest, G. M., New York.

Consumer, Smoke.
Empire Steel & Equipment Co., New York.

Continuous Elevators.
Caldwell & Son Co., H. W., Chicago.

Coppersmiths.
Badger & Sons Co., E. B., Boston.

Contractors, General.
Stone & Webster Engineering Corp., Boston.
Turner Construction Co., New York.
White & Co., J. G., New York.

Controllers.
Cutler-Hammer Mfg. Co., Milwaukee.
Elec. Controller & Supply Co., Cleveland.

Conveying Machinery.
Beaumont Co., R. H., Philadelphia.
Brown Hoisting Mchy. Co., Cleveland.
Browning Eng'g Co., Cleveland.
Caldwell & Sons Co., H. W., Chicago.
Dobbie Foundry & Machine Co., Niagara Falls.
Heyward Co., The, New York.
Hunt Co., C. W., New York.
Interstate Eng'g Co., Cleveland.
Jeffrey Mfg. Co., Columbus.
Lidgerwood Mfg. Co., New York.
Link-Belt Co., Phila.
Maris Bros., Philadelphia.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Trenton Iron Co., Trenton, N. J.
Webster Mfg. Co., Chicago.

Conveying Systems.
Sturtevant Co., B. F., Hyde Park, Mass.

Conveyors, Automatic.
Lamson Consolidated S. S. Co., Boston.

Cooling Towers.
Alberger Condenser Co., New York.
Hart, Jr., & Co., B. Franklin, New York.
Stocker, George J., St. Louis.
Wheeler Condenser & Eng'g Co., N.Y.
Worthington, Henry R., New York.

Copper Window Frames and Sashes.
Badger & Sons Co., E. B., Boston.
Voigtmann & Co., Chicago.

Cordage.
American Mfg. Co., New York.

Core Compound.
Obermayer Co., S., Cincinnati,

Cost Systems.
Baker, L. B., Waterbury, Conn.
Baker-Vawter Co., Chicago.
Cooper & Co., John A., Chicago.
Gunn, Richards & Co., New York.
Webner, F. E., Cincinnati.
Williams & Staff, Stephen T., N. Y.

Cotton Oil Machinery.
Laidlaw-Dunn-Gordon Co., New York.

Couplings.
Almond Mfg. Co., Brooklyn.
Sellers & Co., Inc., Wm., Phila.

Cranes.
Brown Hoisting Mchy. Co., Cleveland.
Browning Eng'g Co., Cleveland.
Bucyrus Co., So. Milwaukee.
Curtis & Co. Mfg. Co., St. Louis.
Dobbie Foundry & Machine Co., Niagara Falls.
Hayward Co., The, New York.
Industrial Works, Bay City, Mich.
Interstate Engineering Co., Cleveland.
Maris Bros., Philadelphia.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit.
Riter-Conley Mfg. Co., Pittsburg.
Sellers & Co., Inc., Wm., Phila.
Wood & Co., R. D., Phila.

Crane Motors.
Browning Eng'g Co., Cleveland.
Western Electric Co., Chicago.

Crucibles.
Dixon Crucible Co., Jos., Jersey City.
Obermayer Co., S., Cincinnati.

Crushers, Ore, Phosphate Rock
Jeffrey Mfg. Co., Columbus.
Lehigh Car, Wheel & Axle Works, Catasauqua, Pa.
Raymond Bros. Impact Pulverizer Co., Chicago.
Smidth & Co., F. L., New York.

Cupolas.
Obermayer Co., S., Cincinnati.
Northern Engineering Works, Detroit.
Riter-Conley Mfg. Co., Pittsburg.

Cutters, Milling.
Pratt & Whitney Co., Hartford.

Damper Regulator.
D'Este Co., Julian, Boston.
Mason Regulator Co., Boston.

Derricks and Fittings.
Brown Hoisting Mchy. Co., Cleveland.
Browning Engineering Co., Cleveland.
Contractors' Plant Mfg. Co., Buffalo.
Dobbie Foundry & Machine Co., Niagara Falls.
Lidgerwood Mfg. Co., New York.
National Equipment Co., Chicago.
Northern Engineering Works, Detroit.

Die Castings.
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Digesters.
Atlantic Works, East Boston, Mass.
Riter-Conley Mfg. Co., Pittsburg.
Tippett & Wood, Phillipsburg, N. J.

Draft, Mechanical.
American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Exeter Machine Wks., Exeter, N. H.
Massachusetts Fan Co., Watertown, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

Drafting Machine.
Kelsey, D. J., New Haven.
Universal Drafting Machine Co., Cleveland.

Drafting Room Equipment.
Kelsey, D. J., New Haven.
Kolesch & Co., New York.
Universal Drafting Machine Co., Cleveland.

Drawing Paper.
Kolesch & Co., New York.

Drilling Machines.
American Tool Wks. Co., Cincinnati.
Barnes Co., W. F. & J., Rockford, Ill.
Clark, Jr., & Co., Jas., Louisville.
Ingersoll-Rand Co., New York.
Keystone Traction Drill Co., Beaver Falls, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Sellers Co., Inc., William, Phila.
Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.

Drills, Diamond Core.
Ingersoll-Rand Co., New York.
Standard Diamond Drill Co., Chicago.

Drills—Rock and Coal.
Clayton Air Compress Wks., N. Y.
Hall Steam Pump Co., Pittsburg.
Ingersoll-Rand Co., New York.

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Keystone Traction Drill Co., Beaver Falls, Pa.
Smidth & Co., F. L., New York.
Standard Diamond Drill Co., Chicago.

Drop-Forged Wrenches.
Williams & Co., J. H., Brooklyn.

Drop Forgings.
Anderson Forge & Machine Co., Detroit, Mich.
Chicago Drop Forge & Fdy. Co., Kensington, Ill.
O. K. Tool Holder Co., Shelton, Pa.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.
Williams & Co., J. H., Brooklyn.
Wyman & Gordon, Worcester, Mass.

Dryers.
Buffalo Fdy. & Mch. Co., Buffalo.
Ruggles-Coles Eng'g Co., New York.

Drying Apparatus.
American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Sturtevant Co., B. F., Hyde Park, Mass.

Dumps, Automatic.
Jeffrey Mfg. Co., Columbus.

Dust Collecting Systems.
Ohio Blower Co., Cleveland.

Dynamos.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus.
Northern Elec. Mfg. Co., Madison.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Dynamos, Steam Turbine.
De Laval Steam Turbine Co., Trenton.

Ejectors.
Buffalo Foundry & Machine Co., Buffalo.
Watson & McDaniel Co., Philadelphia.

Elbows, Pipe.
Lunkenheimer Co., Cincinnati.
Whitlock Coil Pipe Co., Hartford.
Williams Valve Co., D. T., Cincinnati.

Electric Bells.
Ostrander & Co., W. R., New York.
Western Electric Co., Chicago.

Electric Heating Apparatus.
Simplex Elec. Heating Co., Cambridgeport, Mass.
Western Electric Co., Chicago.

Electric Hoists.
Brown Hoisting Mchy. Co., Cleveland.
Browning Engineering Co., Cleveland.
C & C Electric Co., New York.
Hunt Co., C. W., New York.
Dobbie Foundry & Machine Co., Niagara Falls.
Hale & Duncan, Cleveland.
Lambert Hoist Eng. Co. Newark.
Lidgerwood Mfg. Co., New York.
Mead-Morrison Mfg. Co., Boston.
National Equipment Co., Chicago.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit.
Western Electric Co., Chicago.

Elec. Light & Power Plants.
Stone & Webster Engineering Corp., Boston.

Electric Railways.
Stone & Webster Engineering Corp., Boston.

Electrical Furnaces.
Engelhard, Charles, New York.
Hoskins Co., Chicago.

Elec. Measuring Instruments.
Bristol Co., Waterbury, Conn.
Bristol, Wm. H., New York.
Weston Elec. Instrument Co., Waverly Park, Newark, N. J.

Elec. Welding Outfits.
C & C Electric Co., New York.

Elevating and Conveying Machinery.
Dobbie Foundry & Machine Co., Niagara Falls.
Interstate Engineering Co., Cleveland.
Jeffrey Mfg. Co., Columbus.
Lidgerwood Mfg. Co., New York.
Maris Bros., Philadelphia.
National Equipment Co., Chicago.
Northern Engineering Works, Detroit.
Webster Mfg. Co., Chicago.

Elevator Insurance.
Fidelity & Casualty Co., New York.

Elevators.
Caldwell & Son Co., H. W., Chicago.
Curtis & Co. Mfg. Co., St. Louis.
Jeffrey Mfg. Co., Columbus.
Link-Belt Eng'g Co., Phila.
Mead-Morrison Mfg. Co., Boston.
Obermayer Co., S., Cincinnati.
Poole Eng'g Mch. Co., Baltimore.

Elevator Pressure Regulator.
Mason Regulator Co., Boston.

Emery Wheels.
Pittsburg Emery Wheel Co., Pittsburg.

Employers' Liability Insurance.
Fidelity & Casualty Co., New York.

Engineering Instruments.
Alteneder & Sons, Theo., Phila.
Brandis Sons Co., Brooklyn.
Bristol Co., Waterbury, Conn.
Buff & Buff Mfg. Co., Boston.
Dietzgen Co., Eugene, Chicago.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.
Queen & Co., Philadelphia.
Williams, Brown & Earle, Philadelphia.
Young & Sons, Philadelphia.

Engineering Specialties.
D'Este Co., Julian, Boston.
Ferguson Mfg. Co., Boston.
Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.

Engineers.
Arnold Co., Chicago.
Baum & Co., Frank G., San Francisco.
Brill, Geo. M., Chicago.
Collins, D. C. Newman, New York.
Cooper & Co., John A., Chicago.
Demming, Henry C., Harrisburg, Pa.
Doble, Robt. McF., Colorado Springs, Colo.
Green, Carl R., Dayton, O.
Gunn, Richards & Co., New York.
Hale & Duncan, Cleveland.
Hooper, J. H., Chicago.
Hunt & Co., Robt. W., Chicago.
Keyes & Son, F. E., New York.
Kennedy, Julian, Pittsburg.
Kennedy, Walter, Pittsburg.
Loomis-Pettibone Co., New York.
McClure, Son & Co., G. W., Pittsburg.
Palmer, W. K., Kansas City.
Porter, H. F. J., New York.
Roberts, Nathaniel, Demarest, N. J.
Robinson, A. W., Montreal, Canada.
Rockler, H. B., New York.
Stone & Webster Engineering Corp., Boston.
Von Schon, H., Detroit.
Webner, F. E., Cincinnati.
White & Co., J. G., New York.
Williams & Staff, Stephen T., N. Y.
Wood, George R., Pittsburg.

Engines, Blowing.
Southwark Fdy. & Mch. Co., Phila.

Engines, Gas & Gasoline.
(See Gas and Gasoline Engines.)

Engines, Marine.
Atlantic Works, East Boston, Mass.

Engines, Steam.
American Engine Co., Bound Brook, N. J.
American Blower Co., Detroit.
Ball Engine Co., Erie, Pa.
Bristol Co., Waterbury, Conn.
Brown Hoisting Mchy. Co., Cleveland.
Buffalo Forge Co., Buffalo.
Chandler & Taylor Co., Indianapolis.
Harrisburg Fdy. & Mch. Wks., Harrisburg, Pa.
Mecklenburg Iron Works, Charlotte, N. C.
Ohio Blower Co., Cleveland.
Olney & Warrin, New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Southwark Fdy. & Mch. Co., Phila.
Struthers, Wells & Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Troy Engine & Mch. Co., Troy, Pa.
Westinghouse, Church, Kerr & Co., New York.
Westinghouse Mch. Co., Pittsburg.

Evaporators.
Blake Mfg. Co., Geo. F., New York.
Knowles Steam Pump Wks., N. Y.

Excavators.
Browning Engineering Co., Cleveland.
Bucyrus Co., So. Milwaukee, Wis.
Hayward Co., The, New York.
Jeffrey Mfg. Co., Columbus.
Marion Steam Shovel Co., Marion, O.
National Equipment Co., Chicago.
Robins Conveying Belt Co., Passaic, N. J.

Exhaust Heads.
Am. Spiral Pipe Wks., Chicago.
Direct Separator Co., Syracuse.
Hoppes Mfg. Co., Springfield, Ohio.
Sturtevant Co., B. F., Hyde Park, Mass.
Watson & McDaniel Co., Phila.
Whitlock Coil Pipe Co., Hartford.
Wright Mfg. Co., Detroit.

Exhaust Heads (Cast Iron).
Hoppes Mfg. Co., Springfield, O.
Ohio Blower Co., Cleveland.

Expanded Metal.
Roebling Construction Co., N. Y.

Factory Economist.
Baker, L. B., Waterbury.

Fans, Electric.
Western Electric Co., Chicago.
Wing Mfg. Co., L. J., New York.

Fans, Ventilating.
American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Green Fuel Economizer Co., Matteawan, N. Y.
Massachusetts Fan Co., Watertown, Mass.
Power Specialty Co., New York.
Sirocco Engineering Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago.
Wing Mfg. Co., L. J., New York.

Feed Water Heaters and Purifiers.
Blake Mfg. Co., Geo. F., New York.
Goubert Mfg. Co., New York.
Green Fuel Economizer Co., Matteawan, N. Y.
Griscom, Spencer & Co., New York.
Harrison Safety Boiler Wks., Phila.
Hoppes Mfg. Co., Springfield, O.
Keyes & Son, F. E., New York.
Knowles Steam Pump Wks., N. Y.
McGowan Co., John H., Cincinnati
National Pipe Bending Co., New Haven.
Petroleum Iron Wks. Co., Sharon, Pa.
Ross Valve Mfg. Co., Troy.
Scaife & Sons Co., Wm. B., Pittsburg.
Stewart Heater Co., Buffalo.

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Wheeler Condenser & Eng'g Co., New York.
Whitlock Coil Pipe Co., Hartford.
Worthington, Henry R., New York.

Feed Water Regulators.
Chaplin-Fulton Mfg. Co., Pittsburg.
Jerguson Mfg. Co., Boston.

Felt Roofing.
Barrett Mfg. Co., New York.

Files and Rasps.
Carver File Works, Philadelphia.
Barnett Co., G. & H., Phila.
Nicholson File Co., Providence.

Filing Cabinets.
Globe-Wernicke Co., Cincinnati.

Filter Presses.
Am. Tool & Machine Co., Boston.
Moore & Sons Corp., Samuel L., Elizabethport, N. J.
Niles-Bement-Pond Co., New York.

Filters.
Keyes & Son, F. E., New York.
Koven & Bro., L. O., New York.
Ross Valve Mfg. Co., Troy.
Scaife & Sons Co., Wm. B., Pittsburg.
Wright Mfg. Co., Detroit.

Fire-Box Blocks.
McLeod & Henry Co., Troy, N. Y.

Fire Brick.
Maurer & Son, Henry, New York.
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., S., Cincinnati.

Fire Clay.
McLeod & Henry Co., Troy, N. Y.
Carborundum Co., Niagara Falls, N.Y.

Fire Escapes.
Merritt & Co., Philadelphia.

Fire Extinguishers.
Badger & Sons Co., E. B., Boston.

Fire Hose.
Eureka Fire Hose Mfg. Co., New York.

Fireproof Building Materials.
Maurer & Son, Henry, New York.
Roebling Construction Co., New York.

Fireproof Doors.
Rapp, John W., New York.

Fittings.
Pittsburg Valve & Fittings Co., Pittsburg.
Tight Joint Co., New York.

Flanges.
Lunkenheimer Co., Cincinnati.
Williams Valve Co., D. T., Cincinnati.

Flanges—Forged Steel.
Am. Spiral Pipe Wks., Chicago.

Flexible Shafts.
Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.

Flexible Steel Tubing.
Almond Mfg. Co., Brooklyn.

Floor and Sidewalk Lights.
Brooks & Co., T. H., Cleveland.

Fly Wheels.
Poole Eng'g & Mch. Co., Baltimore.

Forges.
Buffalo Forge Co., Buffalo.
Ingersoll-Rand Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Iron and Steel.
Anderson Forge & Machine Co., Detroit, Mich.
Chicago Drop Forge & Fdy. Co., Kensington, Ill.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.
Wyman & Gordon, Worcester.

Foundry Equipment.
American Blower Co., Detroit.
Bicke Mfg. Co., Geo. F., New York.
Buffalo Foundry Co., Buffalo.
Hunt Co., C. W., New York.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit.
Obermayer Co., S., Cincinnati.

Foundry Supplies.
Ingersoll-Rand Co., New York.
Obermayer & Co., S., Cincinnati.
U. S. Graphite Co., Saginaw, Mich.

Friction Clutches.
American Pulley Co., Philadelphia.
Am. Tool & Mch. Co., Boston.
Caldwell & Son Co., H. W., Chicago.
Cutler-Hammer Mfg. Co., Milwaukee.
Elec. Controller & Supply Co., Cleveland.
Link-Belt Co., Phila.
Poole Eng'g & Mch. Co., Baltimore.
Rockwood Mfg. Co., Indianapolis.

Fuel Economizers.
Green Fuel Economizer Co., Matteawan, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Oil Engines.
De La Vergne Mach. Co., New York.

Furnace Builders.
Am. Gas Furnace Co., New York.
Continental Iron Wks., Brooklyn.
Kennedy, Julian, Pittsburg.
Tippett & Wood, Phillipsburg, N. J.
McClure, Son & Co., G. W., Pittsburg.
Morgan Const. Co., Worcester.
Riter-Conley Mfg. Co., Pittsburg.

Fused Silica Ware.
Engelhard, Charles, New York.

Gages—Pressure, Steam, Water.
American Steam Gauge & Valve Mfg. Co., Boston.
Ashton Valve Co., Boston.
Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester.
Hoskins Co., Chicago.
Jerguson Mfg. Co., Boston.
Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.
Star Brass Mfg. Co., Boston.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Standard Gauge Mfg. Co., Syracuse.
Walworth Mfg. Co., Boston.
Williams Valve Co., D. T., Cincinnati.

Galvanizing.
Koven & Bro., L. O., New York.

Galvanometers.
Weston Elec. Instrument Co., Waverly Park, Newark, N. J.

Gas Blowers and Exhausters.
American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Sturtevant Co., B. F., Hyde Park, Mass.

Gas-Composimeters.
Uehling Instrument Co., Passaic, N. J.

Gas Compressors.
Bury Compressor Co., Erie, Pa.

Gas Engine Indicators.
Amer. Steam Gauge & Valve Mfg. Co., Boston.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Gas & Gasoline Engines.
De La Vergne Machine Co., N. Y.
Snow Steam Pump Wks., New York.
Struthers, Wells & Co., Warren, Pa.
Westinghouse Mch. Co., Pittsburg.
Westinghouse, Church, Kerr & Co., New York.

Gas Machines & Generators.
Am. Gas Furnace Co., New York.
Morgan Const. Co., Worcester.
Walworth Mfg. Co., Boston.
Wood & Co., R. D., Phila.

Gas Producers.
Morgan Construction Co., Worcester.
Struthers, Wells & Co., Warren, Pa.
Westinghouse Machine Co., Pittsburg.

Gaskets.
Am. Spiral Pipe Wks., Chicago.
Boston Belting Co., Boston.

Gear Cutting Machines.
Pratt & Whitney Co., Hartford.

Gearing.
Bilgram, Hugo, Phila.
Blake Mfg. Co., Geo. F., New York.
Caldwell & Son Co., H. W., Chicago.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Jeffrey Mfg. Co., Columbus.
New Process Rawhide Co., Syracuse.
Nuttall Co., R. D., Pittsburg.
Phila. Gear Works, Inc., Philadelphia.
Poole Eng'g & Mch. Co., Baltimore.
Sellers Co., Inc., Wm., Phila.
Stow Flexible Shaft Co., Phila.

Generating Sets.
Browning Engineering Co., Cleveland.
Buffalo Forge Co., Buffalo.
Crocker-Wheeler Co., Ampere, N. J.
Hale & Duncan, Cleveland.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago.

Gold Dredging Machinery.
Bucyrus Co., So. Milwaukee.

Gold Milling Machinery.
Mecklenburg Iron Works, Charlotte, N. C.

Graphite.
Dixon Crucible Co., Jos., Jersey City.
Obermayer Co., S., Cincinnati.
U. S. Graphite Co., Saginaw, Mich.

Graphite Bushings.
Graphite Lubricating Co., Bound Brook, N. J.

Grates, Traveling Link.
Green Engineering Co., Chicago.

Grinding Machinery.
Western Electric Co., Chicago.

Grinding & Polishing Mchy.
Clarke, Jr., & Co., Jas., Louisville.
Crocker-Wheeler Co., Ampere, N. J.
Helwig Mfg. Co., St. Paul.
Landis Tool Co., Waynesboro, Pa.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison.
Pratt & Whitney Co., Hartford.
Pittsburg Emery Wheel Co., Pittsburg.
Sellers Co., Inc., William, Phila.
Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.

Grinding & Pulverizing Mchy.
Bradley Pulverizer Co., Boston.
Dunning, W. D., Syracuse.
Lehigh Car, Wheel & Axle Works, Catasauqua, Pa.
Raymond Bros. Impact Pulverizer Co., Chicago.
Smidth & Co., F. L., New York.

Grinding Wheels.
Carborundum Co., Niagara Falls, N.Y.
Pittsburg Emery Wheel Co., Pittsburg.

Grinding Wheels (Alundum).
Norton Co., Worcester, Mass.

Hack Saws.
Niles-Bement-Pond Co., New York.

Hammers, Electric.
Helwig Mfg. Co., St. Paul.
Northern Elec. Mfg. Co., Madison.

Heat Gauges.
Hoskins Co., Chicago.

Heating and Ventilating Apparatus.
American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.

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Drouve Co., G., Bridgeport, Conn.
Exeter Machine Wks. Exeter, N. H.
Griscom, Spencer & Co., New York.
Lord & Burnham Co., Irvington-on-Hudson, N. Y.
Massachusetts Fan Co., Watertown, Mass.
Ohio Blower Co., Cleveland.
Sirocco Engineering Co., New York.
Stewart Heater Co., Buffalo.
Sturtevant Co., B. F., Hyde Park, Mass.
Walworth Mfg. Co., Boston.
Western Electric Co., Chicago.
Wing Mfg. Co., L. J., New York.

Heating Installations (Screens for).

Harrington & King Perforating Co., Chicago.

Hoisting Engines and Mchy.

Brown Hoisting Mchy. Co., Cleveland.
Browning Engineering Co., Cleveland.
Contractors' Plant Mfg. Co., Buffalo.
Dobbie Foundry & Machine Co., Niagara Falls.
Flory Mfg. Co., S., Bangor, Pa.
Hale & Duncan, Cleveland.
Harward Co., New York.
Hunt Co., C. W., New York.
Industrial Works, Bay City, Mich.
Interstate Engineering Co., Cleveland.
Jeffrey Mfg. Co., Columbus.
Lambert Hoist. Eng. Co., Newark.
Lane Bros. Co., Poughkeepsie, N. Y.
Lidgerwood Mfg. Co., New York.
Link-Belt Co., Phila.
Mead-Morrison Mfg. Co., Boston.
National Equipment Co., Chicago.
Northern Engineering Works, Detroit.
Robins Conveying Belt Co., N. Y.
Sellers Co., Wm., Inc., Phila.
Western Electric Co., Chicago.

Hoisting Rope.

American Mfg. Co., New York.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Hose.

Boston Belting Co., Boston.
Eureka Fire Hose Mfg. Co., N. Y.

Hydraulic Fittings.

Tight Joint Co., New York.

Hydraulic Gauges.

Amer. Steam Gauge & Valve Mfg. Co., Boston.
Bristol Co., Waterbury, Conn.

Hydraulic Machinery.

Goulds Mfg. Co., Seneca Falls, N. Y.
Kingsford Foundry & Machine Wks., Oswego, N. Y.
Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.
Wood & Co., R. D., Philadelphia.

Hydraulic Presses.

Watson-Stillman Co., New York.

Hydraulic Rams.

Pelton Water Wheel Co., San Francisco.
Power Specialty Co., New York.

Hydraulic Turbines.

Morris Co., I. P., Philadelphia.

Ice-Mak'g & Refriger. Mchy.

De La Vergne Machine Co., N. Y.
Roelker, H. B., New York.

India Oil Stones.

Norton Co., Worcester, Mass.

Indicators.

Amer. Steam Gauge & Valve Mfg. Co., Boston.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Standard Gauge Mfg. Co., Syracuse.

Industrial Methods.

Baker-Vawter Co., Chicago.
Cooper & Co., John A., Chicago.
Gunn, Richards & Co., New York.
Webner, F. E., Cincinnati.
Williams & Staff, Stephen T., N. Y.

Industrial Railways.

C. W. Hunt Co., New York.
Koppel Co., Arthur, Pittsburg.

Ingots.

Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Injectors.

Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.
Sellers & Co., Inc., Wm., Phila.

Insurance.

Fidelity & Casualty Co., New York.

Internal Gearing.

Nuttall Co., R. D., Pittsburg.

Iron and Steel Tubular Poles.

Electric Railway Equipment Co., Cincinnati.

Iron Window Frames and Sashes.

Voigtmann & Co., Chicago.

Jacks, Hydraulic.

Watson-Stillman Co., New York.

Lamps, Electric.

General Electric Co., New York.
Sawyer-Man Elec. Co., Pittsburg.
Western Electric Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Lathe Dogs.

O. K. Tool Holder Co., Shelton, Conn.

Lathes.

Am. Tool & Mch. Co., Boston.
Am. Tool Works Co., Cincinnati.
Barnes Co., W. F. & J., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Sellers Co., Wm., Inc., Phila.

Lathe Tools.

O. K. Tool Holder Co., Shelton, Conn.

Leather Packing.

Detroit Leather Specialty Co., Detroit.

Lift Bridges.

Scherzer Rolling Lift Bridge Co., Chicago.

Lifting Magnets.

Browning Engineering Co., Cleveland.
Cutler-Hammer Clutch Co., Cleveland.
Elec. Controller & Supply Co., Cleveland.

Light Railways.

Hunt Co., C. W., New York.
Link-Belt Co., Phila.
Robins Conveying Belt Co., N. Y.

Lights, Floor & Sidewalk.

Brooks & Co., T. H., Cleveland.

Line Materials, Electric.

Electric Railway Equipment Co., Cincinnati.

Lockers, Steel.

Merritt & Co., Philadelphia.

Locomotive Cranes.

Brown Hoisting Mchy. Co., Cleveland.
Browning Engineering Co., Cleveland.
Industrial Works, Bay City, Mich.
Interstate Eng'g Co., Cleveland.
Mead-Morrison Mfg. Co., Boston.
National Equipment Co., Chicago.
Northern Engineering Works, Detroit.

Locomotives.

Baldwin Locomotive Wks., Phila.
General Electric Co., New York.
Hunt Co., C. W., New York.
Jeffrey Mfg. Co., Columbus.
Lima Loco & Mch. Co., Lima, O.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Logging Machinery.

Lidgerwood Mfg. Co., New York.
National Equipment Co., Chicago.

Loose Leaf Accounting Forms.

Baker-Vawter Co., Chicago.

Lubricants.

Dixon Crucible Co., Jos., Jersey City.
Obermayer Co., S., Cincinnati.
U. S. Graphite Co., Saginaw, Mich.

Lubricating Graphite.

U. S. Graphite Co., Saginaw, Mich.

Lubricating & Oiling Devices.

Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.
Williams Valve Co., D. T., Cincinnati.

Lubricators.

Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.
Williams Valve Co., D. T., Cincinnati.

Machinery Exhibits.

Bourse, Philadelphia.

Machinery, Second Hand.

Niles-Bement-Pond Co., New York.

Machinists' Small Tools.

Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford.
Sellers Co., William, Inc., Phila.

Malleable Castings.

Jeffrey Mfg. Co., Columbus, O.

Marine Boilers.

Lake Erie Boiler Works, Buffalo.
Morris Co., I. P., Philadelphia.

Measuring Tapes.

Keuffel & Esser Co., New York.
Kolesch & Co., New York.

Mechanical Messenger Service.

Lamson Consolidated S. S. Co., Boston.

Metal Lath.

Roebling Construction Co., N. Y.

Metaline Bushings.

North American Metaline Co., Long Island City, N. Y.

Meters, Electric.

General Electric Co., New York.
Western Electric Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Weston Elec. Inst. Co., Waverly Park, Newark, N. J.

Milling Machines.

Adams Co., Dubuque, Iowa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Underwood & Co., H. B., Phila.

Mill Supplies.

Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.
Robins Conveying Belt Co., Passaic, N. J.
Williams Valve Co., D. T., Cincinnati.

Mine Cars.

Hunt Co., C. W., New York.
Jackson Mfg. Co., Harrisburg, Pa.
Jeffrey Mfg. Co., Columbus.

Mining Machinery.

Bradley Pulverizing Co., Boston.
Brown Hoisting Mchy. Co., Cleveland.
Browning Engineering Co., Cleveland.
Blake Mfg. Co., Geo. F., New York.
Crocker-Wheeler Co., Ampere, N. J.
Deane Steam Pump Co., New York.
General Electric Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Hale & Duncan, Cleveland.
Ingersoll-Rand Co., New York.
Jeffrey Mfg. Co., Columbus.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., N. Y.

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Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
Marion Steam Shovel Co., Marion, O.
McGowan Co., John H., Cincinnati.
Mead-Morrison Mfrg. Co., Boston.
Mecklenburg Iron Works, Charlotte, N. C.
Norwalk Iron Wks., So. Norwalk, Ct.
Power Specialty Co., New York.
Raymond Bros. Impact Pulverizer Co., Chicago.
Robins Conveying Belt Co., Passaic, N. J.
Smidth & Co., F. L., New York.
Snow Steam Pump Wks., New York.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Worthington, Henry R., New York.

Motors, Electric.

Browning Engineering Co., Cleveland.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Cutler-Hammer Mfg. Co., Milwaukee.
Elec. Controller & Supply Co., Cleveland.
General Electric Co., New York.
Hale & Duncan, Cleveland.
Jeffrey Mfg. Co., Columbus.
Northern Elec. Mfg. Co., Madison.
Stow Mfg. Co., Binghamton, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Motor Parts.

Electric Railway Equipment Co., Cincinnati.

Motors, Steam Turbine.

De Laval Steam Turbine Co., Trenton.

Moulding Machines.

Blake Mfg. Co., Geo. F., New York.
Obermayer Co., S., Cincinnati.
Power Specialty Co., New York.

Name Plates.

Schwerdtle Stamp Co., Bridgeport.

Naphtha Gas Machines.

Am. Gas Furnace Co., New York.

Nickel for Nickel Steel.

Orford Copper Co., New York.

Nozzle Piezometer Gauge.

Amer. Steam Gauge & Valve Mfg. Co., Boston.

Office Furniture.

Globe-Wernicke Co., Cincinnati.

Ohmmeters.

Weston Elec. Instrument Co., Waverly Park, Newark, N. J.

Oil Burners.

Petroleum Iron Wks. Co., Sharon, Pa.

Oil Engines.

De La Vergne Machine Co., N. Y.
Moore & Sons Corp., Sam'l L., Elizabethport, N. J.

Oil Refining Plants.

Petroleum Iron Wks. Co., Sharon, Pa.

Oilless Bearings.

North American Metaline Co., Long Island City, N. Y.

Oils and Lubricants.

U. S. Graphite Co., Saginaw, Mich.

Oil Stones.

Carborundum Co., Niagara Falls, N.Y.
Norton Co., Worcester, Mass.

Oil Tanks.

Wright Mfg. Co., Detroit.

Packing.

Boston Belting Co., Boston.
Chaplin-Fulton Mfg. Co., Pittsburg.
Detroit Leather Specialty Co., Detroit.
Jenkins Brothers, New York.
Pennsylvania Rubber Co., Jeanette, Pa.

Paint Graphite.

Obermayer Co., S., Cincinnati.
U. S. Graphite Co., Saginaw, Mich.

Paints and Varnishes.

Dixon Crucible Co., Jos., Jersey City.
U. S. Graphite Co., Saginaw, Mich.

Paper-Mill Machinery.

Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Jeffrey Mfg. Co., Columbus.
Keyes & Son, F. E., New York.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Robins Conveying Belt Co., N. Y.
Snow Steam Pump Wks., New York.
Worthington, Henry R., New York.

Patent Attorneys.

Dieterich, C. A., New York.
Evans, Wilkins & Co., Washington, D. C.
Hill, Louis A., Washington, D. C.
Macdonald & Macdonald, New York.
Weeks, Edw. M., Washington, D. C.

Pattern-Makers' Machinery.

Fay & Egan Co., Cincinnati.
Pratt & Whitney Co., Hartford.

Pavement Filler.

Barrett Mfg. Co., New York.

Penstocks.

Atlantic Works, East Boston, Mass.
Lake Erie Boiler Works, Buffalo.
Petroleum Iron Wks. Co., Sharon, Pa.
Walsh's Holyoke Steam Boiler Co., Holyoke, Mass.

Perforated Metal.

Caldwell & Son Co., H. W., Chicago.
Harrington & King Perforating Co., Chicago.

Phosphor Bronze.

Lunkenheimer Co., Cincinnati.
Phosphor Bronze Smelt. Co., Phila.
Poole Eng'g & Mch. Co., Baltimore.

Pile Drivers.

Bucyrus Co., So. Milwaukee.
Ingersoll-Rand Co., New York.
Interstate Engineering Co., Cleveland.
National Equipment Co., Chicago.

Pinions.

New Process Raw Hide Co., Syracuse.

Pipe.

Am. Spiral Pipe Wks., Chicago.
Koven & Bro., L. O., New York.
Lynchburg Foundry Co., Lynchburg, Va.
Pelton Water Wheel Co., Oakland, Cal.
Petroleum Iron Wks. Co., Sharon, Pa.
Riter-Conley Mfg. Co., Pittsburg.
U. S. Cast Iron Pipe & Fdy. Co., Phila.
Walworth Mfg. Co., Boston.
Whitlock Coil Pipe Co., Hartford.

Pipe Bends.

National Pipe Bending Co., New Haven.
Walworth Mfg. Co., Boston.
Whitlock Coil Pipe Co., Hartford.

Pipe-Cutting and Threading Machines.

Armstrong Mfg. Co., Bridgeport.
Cox & Sons Co., Bridgeton, N. J.
Crane Co., Chicago.
Niles-Bement-Pond Co., New York.
Saunders' Sons, Inc., D., Yonkers.
Walworth Mfg. Co., Boston.

Pipe—Spiral Riveted.

Amer. Spiral Pipe Wks., Chicago.

Pipe Fittings, Cast Iron.

Amer. Spiral Pipe Wks., Chicago.
Pelton Water Wheel Co., San Francisco.
Pittsburg Valve & Fittings Co., Pittsburg.
Walworth Mfg. Co., Boston.

Pitch.

Barrett Mfg. Co., New York.

Planers.

American Tool Wks. Co., Cincinnati.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Planing Mill Machinery.

Fay & Egan Co., Cincinnati.

Pneumatic Tools.

Clayton Air Compress. Wks., N. Y.
Curtis & Co. Mfg. Co., St. Louis.
Helwig Mfg. Co., St. Paul.
Ingersoll-Rand Co., New York.

Pneumatic Tubes.

Lamson Consolidated S. S. Co., Boston.

Poles, Iron and Steel Tubular.

Electric Railway Equipment Co., Cincinnati.

Polishing Blocks & Wheels.

Carborundum Co., Niagara Falls, N.Y.
Norton Co., Worcester, Mass.

Pop Safety Valves.

American Steam Gauge & Valve Mfg. Co., Boston.
Ashton Valve Co., Boston.
Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.
Star Brass Mfg. Co., Boston.

Portable Drilling Machines.

Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Star Drilling Mach. Co., Akron, O.
Underwood & Co., H. B., Phila.

Portable Railways.

Koppel Co., Arthur, Pittsburg.

Portable Tools.

Underwood & Co., H. B., Phila.

Portland Cement.—See Cement.

Powder Mixers.

Dunning, W. D., Syracuse.

Power-Plant Equipment.

Hale & Duncan, Cleveland.

Power-Transmission Mchy.

Almond Mfg. Co., T. R., Brooklyn.
American Pulley Co., Philadelphia.
Brown Hoisting Mchy. Co., Cleveland.
Browning Engineering Co., Cleveland.
Caldwell & Son Co., H. W., Chicago.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Hayward Co., The, New York.
Jeffrey Mfg. Co., Columbus.
Link-Belt Co., Phila.
Mead-Morrison Mfg. Co., Boston.
Mecklenburg Iron Works, Charlotte, N. C.
Morse Chain Co., Ithaca, N. Y.
Olney & Warrin, New York.
Niles-Bement-Pond Co., New York.
Northern Electric Mfg. Co., Madison.
Robins Conveying Belt Co., N. Y.
Rockwood Mfg. Co., Indianapolis.
Webster Mfg. Co., Chicago.
Western Electric Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Wood & Co., R. D., Phila.

Preservative, Wood.

McKinney Co., C. S., New York.

Pressed Steel Pulleys.

American Pulley Co., Philadelphia.

Presses and Dies.

Curtis & Curtis Co., Bridgeport.
Niagara Mch. & Tool Wks., Buffalo.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Watson-Stillman Co., New York.
Wood & Co., R. D., Phila.

Production Engineers.

Williams & Staff, Stephen T., N. Y.

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Prospecting Drills.
Ingersoll-Rand Co., New York.
Keystone Traction Drill Co., Beaver Falls, Pa.
Standard Diamond Drill Co., Chicago.
Star Drilling Machine Co., Akron, O.

Pulleys, Shafting & Hangers.
Am. Tool & Machine Co., Boston.
American Pulley Co., Philadelphia.
Caldwell & Son Co., H. W., Chicago.
Fay & Egan Co., Cincinnati.
Jeffrey Mfg. Co., Columbus.
Poole Eng'g & Mch. Co., Baltimore.
Robins Conveying Belt Co., Passaic, N. J.
Rockwood Mfg. Co., Indianapolis.
Sellers & Co., Inc., Wm., Phila.

Pulleys, Wrought Steel
American Pulley Co., Philadelphia.

Pulverizing Mills.
Dunning, W. D., Syracuse.
Lehigh Car, Wheel & Axle Works, Catasauqua, Pa.
Raymond Bros. Impact Pulverizer Co., Chicago.
Smidth & Co., F. L., New York.

Pump Governors.
Albany Steam Trap Co., Albany.
Chaplin-Fulton Mfg. Co., Pittsburg.
Mason Regulator Co., Boston.

Pumps and Pumping Mchy.
Albany Steam Trap Co., Albany.
Alberger Pump Co., New York.
Blake Mfg. Co., Geo. F., New York.
Bucyrus Co., So. Milwaukee.
Buffalo Forge Co., Buffalo.
Cameron Steam Pump Wks., N. Y.
Clayton Air Compress. Wks., N. Y.
Deane Steam Pump Co., New York.
De Laval Steam Turbine Co., Trenton.
Deming Co., Salem, Ohio.
Goulds Mfg. Co., Seneca Falls, N. Y.
Guild & Garrison, Brooklyn.
Hall Steam Pump Co., Pittsburg.
Holly Mfg. Co., New York.
Ingersoll-Rand Co., New York.
Kingsford Foundry & Machine Wks., Oswego, N. Y.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Lawrence Mch. Co., Lawrence, Mass.
Lawrence Pump & Engine Co., Lawrence Mass.
McGowan Co., John H., Cincinnati.
Mecklenburg Iron Works, Charlotte, N. C.
Morris Co., I. P., Philadelphia.
Morris Machine Wks., Baldwinsville, N. Y.
Snow Steam Pump Wks., New York.
Southwark Fdy. & Mch. Co., Phila.
Watson-Stillman Co., New York.
Wheeler Condenser & Eng'g Co., N. Y.
Wood & Co., R. D., Phila.
Worthington, Henry R., New York.

Pumps, Syphon.
Chaplin-Fulton Mfg. Co., Pittsburg.

Pump Pressure Regulator.
D'Este Co., Julian, Boston.
Mason Regulator Co., Boston.

Punching & Shearing Mchy.
Buffalo Forge Co., Buffalo.
Morgan Construction Co., Worcester.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Wood & Co., R. D., Phila.

Pyrometers.
Amer. Steam Gauge & Valve Mfg. Co., Boston.
Bristol Co., Waterbury, Conn.
Bristol, Wm. H., New York.
Engelhard, Charles, New York.
Hoskins Co., Chicago.
Queen & Co., Philadelphia.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Uehling Instrument Co., Passaic,

Quarry Machinery.
Brown Hoisting Mchy. Co., Cleveland.
Browning Engineering Co., Cleveland.
Flory Mfg. Co., S., Bangor, Pa.
Ingersoll-Rand Co., New York.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
McGowan Co., John H., Cincinnati.
Mead-Morrison Mfg. Co., Boston.
National Equipment Co., Chicago.
Northern Engineering Works, Detroit.
Robins Conveying Belt Co., Passaic, N. J.
Star Drilling Machine Co., Akron, O.

Quartz Glass.
Engelhard, Charles, New York.

Racks—Machine Cut.
Nuttall Co., R. D., Pittsburg.

Rail Braces.
Rail Joint Co., New York.

Rail Joints.
Rail Joint Co., New York.

Railway Shop Machinery.
Barnes Co., W. F. & J., Rockford, Ill.
Brown Hoisting Mchy. Co., Cleveland.
Clayton Air Compress. Wks., N. Y.
Fay & Egan Co., Cincinnati.
Laidlaw-Dunn-Gordon Co., New York.
Niles-Bement-Pond Co., New York.
Norwalk Iron Wks., So. Norwalk, Ct.
Pratt & Whitney Co., Hartford.
Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.
Underwood & Co., H. B., Phila.

Rawhide Gears.
New Process Raw Hide Co., Syracuse.
Phila. Gear Works, Inc., Philadelphia.

Razor Hones.
Carborundum Co., Niagara Falls, N.Y.

Ready Roofing.
Barrett Mfg. Co., New York.

Reamers.
Ingersoll-Rand Co., New York.
Pratt & Whitney Co., Hartford.

Reinforced Concrete Steel.
Roebling Construction Co., New York.
Turner Construction Co., New York.

Resistance Banks and Units.
Elec. Controller & Supply Co., Cleveland.

Rheostats.
Simplex Elec. Heat. Co., Cambridge, Mass.

Rheostat Regulator.
Mason Regulator Co., Boston.

Riveting Machines.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sellers Co., Wm., Inc., Phila.
Wood & Co., R. D., Phila.

Rock Breakers.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., Passaic, N. J.

Roller Bearings.
Hyatt Roller Bearing Co., Newark.

Rolling Lift Bridges.
Scherzer Rolling Lift Bridge Co., Chicago.

Rolling Mill Machinery.
Crocker-Wheeler Co., Ampere, N. J.
Morgan Construction Co., Worcester.
Niles-Bement-Pond Co., New York.
Poole Eng'g & Mch. Co., Baltimore.
Robins Conveying Belt Co., Passaic, N. J.

Roofing.
Barber Asphalt Paving Co., Phila.
Barrett Mfg. Co., New York.
Bird Co., J. A. & W., Boston.
Stowell Mfg. Co., Jersey City.

Roofing Materials.
Barrett Mfg. Co., New York.

Rope.
American Mfg. Co., New York.

Rope Transmission.
American Mfg. Co., New York.
Caldwell & Son Co., H. W., Chicago.
Hunt Co., C. W., New York.
Jeffrey Mfg. Co., Columbus.
Link-Belt Co., Phila.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Rubber Goods.
Boston Belting Co., Boston.
Jenkins Bros., New York.

Rubbing and Sharpening Stones,
Norton Co., Worcester.

Sand Mixers and Sifters.
Obermayer Co., S., Cincinnati.

Sand Paper—
(See Carborundum Paper and Cloth.)

Sash Operating Device.
Drouve Co., G., Bridgeport, Conn.
Lord & Burnham Co., Irvington-on-Hudson, N. Y.

Saw-Mill Machinery.
Chandler & Taylor Co., Indianapolis.
Curtis & Co. Mfg. Co., St. Louis.
Fay & Egan, Cincinnati.
Jeffrey Mfg. Co., Columbus.

Saws, Hack.
Niles-Bement-Pond Co., New York.

Scales.
Automatic Weighing Machine Co., Newark.

Scientific Books.
Baird & Co., Henry Carey, Phila.

Screens, Mining.
Harrington & King Perforating Co., Chicago.
Jeffrey Mfg. Co., Columbus.
Ludlow-Saylor Wire Co., St. Louis.

Screens, Rolled Slot.
Ludlow-Saylor Wire Co., St. Louis.

Screw Machines.
Jones & Lamson Mch. Co., Springfield, Vt.
National-Acme Mfg. Co., Cleveland.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Screw Plates.
Card Mfg. Co., S. W., Mansfield, Mass.

Seamless Steel Tubing.
Lees-Williams Co., Pittsburg.

Separators, Pneumatic.
Sturtevant Co., B. F., Hyde Park, Mass.

Separators, Steam and Oil.
American Tool & Mch. Co., Boston.
Austin Separator Co., Syracuse.
Davis Co., John, Chicago.
D'Este Co., Julian, Boston.
Direct Separator Co., Syracuse.
Goubert Mfg. Co., New York.
Harrison Safety Boiler Wks., Phila.

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Hoppes Mfg. Co., Springfield O.
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Ohio Blower Co., Cleveland.
Potter Separator Co., Newburgh, N.Y.
Watson & McDaniel Co., Phila.
Whitlock Coil Pipe Co., Hartford.
Williams Valve Co., D. T., Cincinnati.
Wright Mfg. Co., Detroit.

Sewage Disposal Apparatus.
Merritt & Co., Philadelphia.

Sewage Ejectors.
Merritt & Co., Philadelphia.

Shaft Couplings, Flexible.
Elec. Controller & Supply Co., Cleveland.

Shapers.
Am. Tool Works Co., Cincinnati.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Sharpening Stones.
Carborundum Co., Niagara Falls, N.Y.
Norton Co., Worcester, Mass.

Sheathing Papers.
Barrett Mfg. Co., New York.

Shelving, Steel.
Merritt & Co., Philadelphia.

Shutters (Fire).
Kinnear Mfg. Co., Columbus.

Skylights.
Drouve Co., G., Bridgeport, Conn.
Van Noorden Co., E., Boston.

Slate Machinery.
Flory Mfg. Co., S., Bangor, Pa.

Smoke Consumer.
Empire Steel & Equipment Co., New York.

Special Machinery.
Moore & Sons Corp., Samuel L., Elizabethport, N. J.
Morris Co., I. P., Philadelphia.

Speed Controllers.
Foster Engineering Co., Newark.

Spiral Gears.
Nuttall Co., R. D., Pittsburg.
Phila. Gear Works, Inc., Philadelphia.

Stacks.
Atlantic Works, East Boston, Mass.
Koven & Bro., L. O., New York.
Olney & Warrin, New York.
Petroleum Iron Wks. Co., Sharon, Pa.
Smith & Son Co., Sam'l, Paterson,

Stamps—Steel, Alphabets and Figures.
Schwerdtle Stamp Co., Bridgeport.

Stamps, Time.
Automatic Time Stamp Co., Boston.

Stand Pipes.
Petroleum Iron Wks. Co., Sharon, Pa.
Smith & Son Co., Sam'l, Paterson,
Struthers, Wells & Co., Warren, Pa.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.

Steam Engine Indicators
American Steam Gauge & Valve Mfg. Co., Boston.
Star Brass Mfg. Co., Boston.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Steam Fitters' Supplies.
Williams Valve Co., D. T., Cincinnati.

Steam Hammers.
Buffalo Foundry & Machine Co., Buffalo.

Steam-Regulat'g Appliances.
Albany Steam Trap Co., Albany.
Crane Co., Chicago.
D'Este Co., Julian, Boston.
Foster Engineering Co., Newark.
Harrison Safety Boiler Wks., Phila.
Jenkins Bros., New York.
Lunkenheimer Co., Cincinnati.
Mason Regulator Co., Boston.
Pittsburgh Valve & Fittings Co., Pittsburgh.
Powell Co., Wm., Cincinnati.
Power Specialty Co., New York.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Walworth Mfg. Co., Boston.
Watson & McDaniel Co., Phila.
Williams Valve Co., D. T., Cincinnati.

Steam Shovels.
Browning Engineering Co., Cleveland.
Bucyrus Co., Milwaukee.
Hunt Co., C. W., New York.
Marion Steam Shovel Co., Marion, O.
Mead-Morrison Mfg. Co., Boston.

Steam Specialties.
American Steam Gauge & Valve Mfg. Co., Boston.
Powell Co., Wm., Cincinnati.
Wright Mfg. Co., Detroit.

Steam Traps.
Albany Steam Trap Co., Albany.
American Blower Co., Detroit.
Blake Mfg. Co., Geo. F., New York.
D'Este Co., Julian, Boston.
Chaplin-Fulton Mfg. Co., Pittsburg.
Lindstrom, John T., Allentown, Pa.
Ohio Blower Co., Cleveland.
Pittsburgh Valve & Fittings Co., Pittsburgh.
Sturtevant Co., B. F., Hyde Park, Mass.
Walworth Mfg. Co., Boston.
Watson & McDaniel Co., Phila.
Williams Valve Co., D. T., Cincinnati.
Wright Mfg. Co., Detroit.

Steam Fitters' Supplies.
Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.

Steam Hot Blast Apparatus.
American Blower Co., Detroit.
Sturtevant Co., B. F., Hyde Park, Mass.

Steel.
Jessop & Sons, Wm., New York.
Walworth Mfg. Co., Boston.
Wyman & Gordon, Worcester.

Steel Balls.
American Ball Co., Providence.
Chapman Ball Bearing Co., Boston.

Steel Barrows.
Jackson Mfg. Co., Harrisburg, Pa.

Steel Concrete Construction.
Berlin Const'n Co., Berlin, Conn.
Turner Construction Co., New York.

Steel, High Speed.
Jessop & Sons, Wm., New York.
Wyman & Gordon, Worcester.

Steel, Nickel.
Orford Copper Co., New York.

Steel Tubing, Seamless.
Lees-Williams Co., Pittsburg.

Stencils.
Schwerdtle Stamp Co., Bridgeport.

Stokers—Mechanical.
Babcock & Wilcox Co., New York.
Harrisburg Foundry & Mach. Wks., Harrisburg, Pa.
Lenher Engineering Co., New York.
Under-Feed Stoker Co., Chicago.
Westinghouse Mch. Co., Pittsburg.

Strainers.
Lunkenheimer Co., Cincinnati.

Structural Iron Work.
Berlin Const'n Co., Berlin, Conn.
Brown Hoisting Mchy. Co., Cleveland.
Northern Engineering Works, Detroit.
Riter-Conley Mfg. Co., Pittsburg.
Scaife & Sons Co., Wm. B., Pittsburg.
Turner Construction Co., New York.

Sugar-House Machinery.
Am. Tool & Mch. Co., Boston.
Blake Mfg. Co., Geo. F., New York.

Superheaters.
Babcock & Wilcox Co., New York.
Power Specialty Co., New York.

Suspension Bunkers.
Berquist, A. Samuel, Brooklyn.

Switchboards.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Western Electric Co., Chicago.

Tachometers.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Tanks.
Atlantic Works, East Boston, Mass.
Koven & Bro., L. O., New York.
Mecklenburg Iron Wks., Charlotte, N. C.
Olney & Warrin, New York.
Petroleum Iron Wks. Co., Sharon, Pa.
Riter-Conley Mfg. Co., Pittsburg.
Scaife & Sons Co., Wm. B., Pittsburg.
Smith & Son Co., Sam'l, Paterson,
Struthers, Wells & Co., Warren, Pa.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.

Taps and Dies.
Card Mfg. Co., S. W., Mansfield, Mass.
Crane Co., Chicago.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford.

Tapes, Measuring.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.

Temperature Regulators.
D'Este Co., Julian, Boston.

Tenoning Machines.
Fay & Egan Co., Cincinnati.

Thermometers.
Bristol Co., Waterbury.
Hohmann & Maurer Mfg. Co., Rochester.
Queen & Co., Philadelphia.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Williams, Brown & Earle, Philadelphia.

Tiling, Rubber.
Pennsylvania Rubber Co., Jeanette, Pa.

Time Checks.
Schwerdtle Stamp Co., Bridgeport.

Time Stamps, Automatic.
Automatic Time Stamp Co., Boston
Calculagraph Co., New York.

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Tool Holders.
O. K. Tool Holder Co., Shelton, Conn.

Tracing Cloth.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.

Trade Marks.
Macdonald & Macdonald, New York.

Traveling Link Grates.
Green Engineering Co., Chicago.

Trolleys.
Browning Engineering Co., Cleveland.
Curtis & Co. Mfg. Co., St. Louis.
Maris Bros., Philadelphia.
Northern Engineering Works, Detroit.

Tumbling Barrels.
Northern Engineering Works, Detroit.

Tumbling Mills.
Obermayer Co., S., Cincinnati.

Tubes, Pneumatic.
Lamson Consolidated S. S. Co., Boston.

Tubing, Seamless Steel.
Lees-Williams Co., Pittsburg.

Tubular Poles—Iron & Steel.
Electric Railway Equipment Co., Cincinnati.

Turbines, Steam.
Allis-Chalmers Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton.
Dake American Steam Turbine Co., Grand Rapids, Mich.
General Electric Co., Schenectady.
Morris Co., I. P., Philadelphia.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Mch. Co., Pittsburg.
Wheeler Condenser & Eng. Co., N. Y.
Wing Mfg. Co., L. J., New York.

Turbines, Water.
Pelton Water Wheel Co., San Francisco.

Turn Tables.
Mead-Morrison Mfg. Co., Boston.
Northern Engineering Works, Detroit.
Sellers & Co., Inc., Wm., Phila.
Tippett & Wood, Phillipsburg, Pa.

Turret Heads.
Almond Mfg. Co., T. R., Brooklyn.

Turret Lathes.
American Tool & Mch. Co., Boston.
American Tool Wks. Co., Cincinnati.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Twist Drills.
Pratt & Whitney Co., Hartford.

Underground Conduit Systems.
Gest, G. M., New York.

Vacuum and Draft Gauges.
Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester.
Standard Gauge Mfg. Co., Syracuse.

Vacuum Pumps.
Alberger Condenser Co., New York.
Blake Mfg. Co., Geo. F., New York.
Buffalo Forge Co., Buffalo.
Bury Compressor Co., Erie, Pa.
Clayton Air-Compres. Wks., N. Y.
Deane Steam Pump Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Guild & Garrison, Brooklyn.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
McGowan Co., John H., Cincinnati.
Snow Steam Pump Wks., New York.
Wheeler Condenser & Eng. Co., N. Y.
Worthington, Henry R., New York.

Valves—Gas, Steam and Water.
American Steam Gauge & Valve Mfg. Co., Boston.
Ashton Valve Co., Boston.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Chaplin-Fulton Mfg. Co., Pittsburgh.
Crane Co., Chicago.
Davis Co., John, Chicago.
D'Este Co., Julian, Boston.
Foster Eng'g Co., Newark.
Jenkins Bros., New York.
Jerguson Mfg. Co., Boston.
Lunkenheimer Co., Cincinnati.
McGowan Co., John H., Cincinnati.
Mason Regulator Co., Boston.
Pittsburg Valve & Fittings Co., Pittsburg.
Powell Co., Wm., Cincinnati.
Ross Valve Mfg. Co., Troy.
Star Brass Mfg. Co., Boston.
Walch & Wyeth, Chicago.
Walworth Mfg. Co., Boston.
Watson & McDaniel Co., Phila.
Williams Valve Co., D. T., Cincinnati.
Wood & Co., R. D., Philadelphia.

Valves, Reducing.
Chaplin-Fulton Mfg. Co., Pittsburg.
D'Este Co., Julian, Boston.
Mason Regulator Co., Boston.
Watson & McDaniel Co., Philadelphia.
Williams Valve Co., D. T., Cincinnati.

Ventilating Apparatus.
American Blower Co., Detroit.
Bristol, Wm. H., New York.
Buffalo Forge Co., Buffalo.
Exeter Machine Wks., Exeter, N. H.
Massachusetts Fan Co., Watertown, Mass.
Ohio Blower Co., Cleveland.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago.
Wing Mfg. Co., L. J., New York.

Ventilating Apparatus (Screens for).
Harrington & King Perforating Co., Chicago.

Voltmeters.
Bristol Co., Waterbury, Conn.
Bristol, Wm. H., New York.
Western Electric Co., Chicago.
Weston Elec. Instrument Co., Waverly Park, Newark.

Watchman's Time Clocks.
Ostrander & Co., W. R., New York.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Water Columns.
Jerguson Mfg. Co., Boston.

Water Meters.
Worthington, Henry R., New York.

Water Purifying Apparatus.
Harrison Safety Boiler Wks., Phila.
Keyes & Son, F. E., New York.
Scaife & Sons Co., Wm. B., Pittsburg.

Water Softening Apparatus.
Harrison Safety Boiler Wks., Phila.
Keyes & Son, F. E., New York.
Scaife & Sons Co., Wm. B., Pittsburg.

Water Supply.
Hudson Engineering Co., New York.

Water Towers, Iron & Steel.
Tippett & Wood, Phillipsburg, N. J.

Water-Wheels.
Mecklenberg Iron Wks., Charlotte, N. C.
Pelton Water Wheel Co., San Francisco.
Poole Eng'g & Mch. Co., Baltimore.
Power Specialty Co., New York.
Wood & Co., R. D., Phila.

Water-Wheel Governors.
Woodward Governor Co., Rockford, Ill.

Water-Works Pumping Mchy.
Buffalo Forge Co., Buffalo.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Holly Mfg. Co., New York.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Lawrence Mch. Co., Lawrence, Mass.
Snow Steam Pump Wks., New York.
Southwark Fdy. & Mch. Co., Phila.
Wood & Co., R. D., Phila.
Worthington, Henry R., New York.

Water-Works Supplies.
Power Specialty Co., New York.

Wells—Artesian.
Clayton Air Compress. Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.

Well Drilling Machines.
Keystone Traction Drill Co., Beaver Falls, Pa.
Star Drilling Machine Co., Akron, O.
Williams Bros., Ithaca, N. Y.

Well Supplies.
Laidlaw-Dunn-Gordon Co., New York.
Star Drilling Machine Co., Akron, O.
Williams Bros., Ithaca, N. Y.

Whistles.
Amer. Steam Gauge & Valve Mfg. Co., Boston.
Ashton Valve Co., Boston.
Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Window Frames, Iron and Copper.
Badger & Sons Co., E. B., Boston.
Voigtmann & Co., Chicago.

Windows.
Van Noorden Co., E., Boston.

Window Sashes, Iron and Copper.
Voigtmann & Co., Chicago.

Wire-Drawing Machinery.
Morgan Construction Co., Worcester.

Wire Cloth and Screen.
Harrington & King Perforating Co., Chicago.
Ludlow-Saylor Wire Co., St. Louis.

Wire Lath.
Ludlow-Saylor Wire Co., St. Louis.
Roebling Construction Co., N. Y.

Wire Rope.
Jeffrey Mfg. Co., Columbus.
National Equipment Co., Chicago.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Wood Blocks.
U. S. Wood Preserving Co., New York.

Wood Preservative.
McKinney Co., C. S., New York.

Wood-Working Machinery.
Fay & Egan Co., Cincinnati.
Ingersoll-Rand Co., New York.

Worm Gearing.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg.
Phila. Gear Works, Inc., Philadelphia.

Wrenches.
Williams & Co., J. H., Brooklyn.

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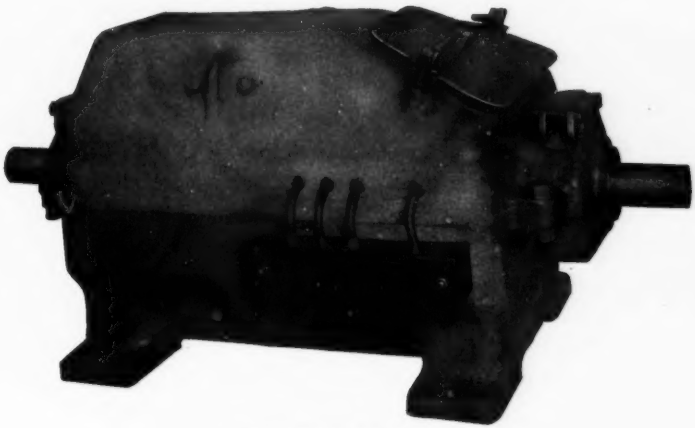
General Electric Company

MILL MOTORS

For Direct and Alternating Current



From 25 to 150 H. P.
110, 220 and 500 Volts D. C. 220, 440 and 550 Volts A. C.

Designed with a full understanding of the severity of steel mill service and built electrically and mechanically to meet these demands.

Assembled in unusually heavy dust proof steel frames.

Alternating and direct current motors of same horse power can be used interchangeably since over all dimensions are identical.

Four Big Rough Bolts hold motor frame together.
Four Big Rough Bolts hold motor to foundation.

Motors supplied either with or without axle brackets for back gearing.

1640

New York Office: 44 Broad St.

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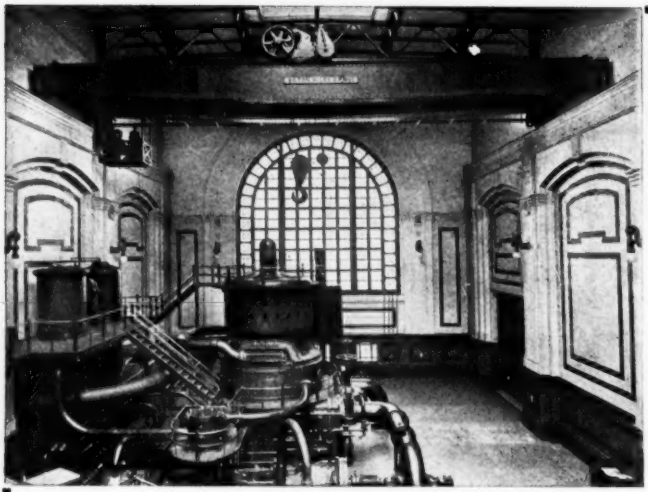

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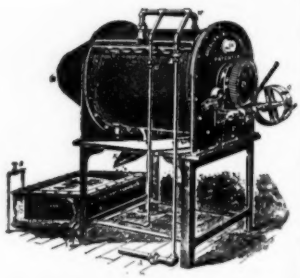

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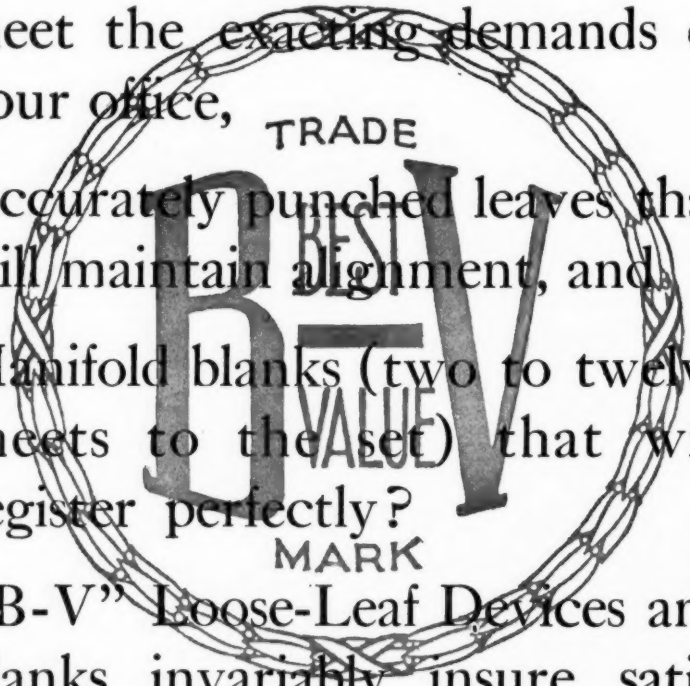

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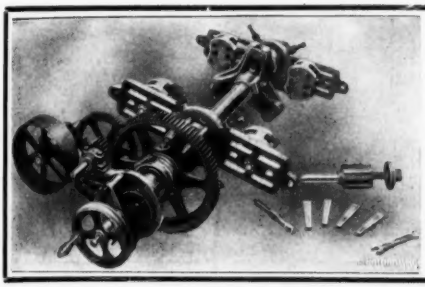

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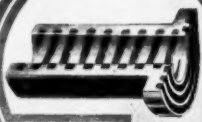

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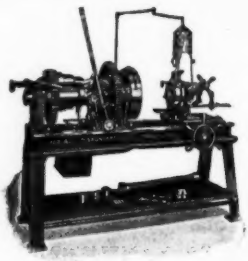

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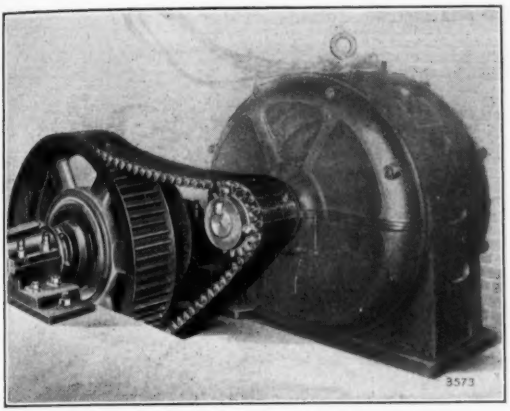

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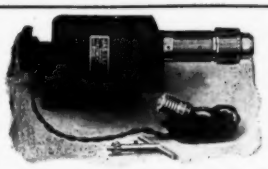

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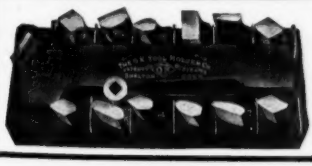

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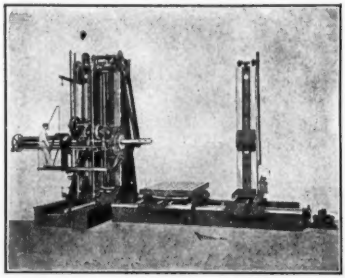

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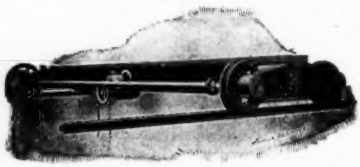

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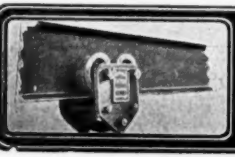

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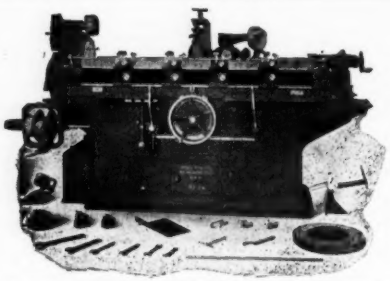

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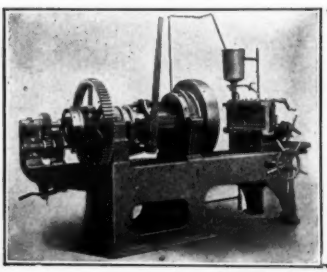

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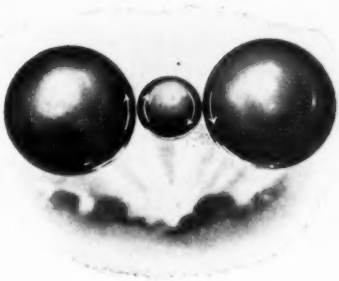

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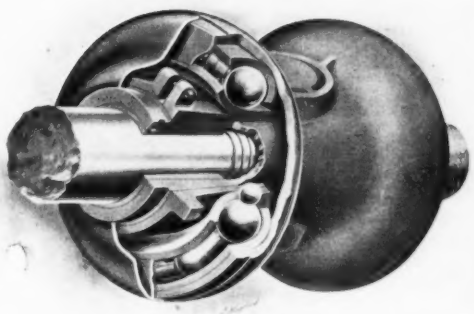

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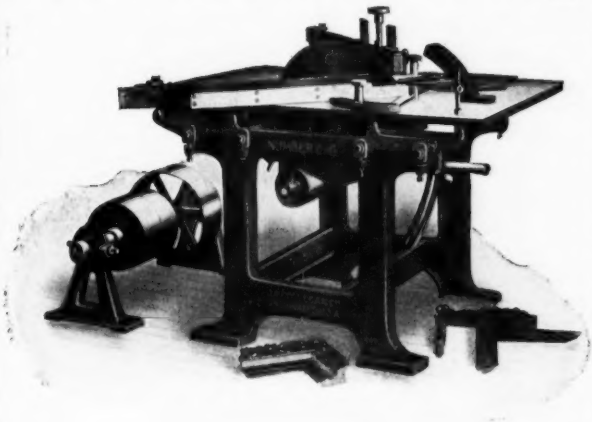

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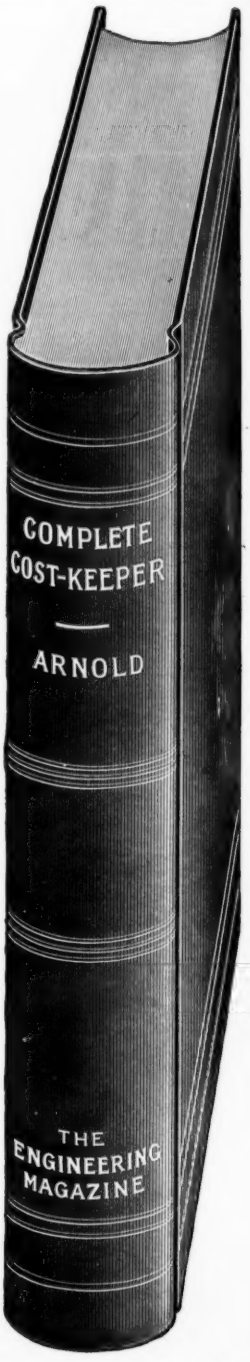

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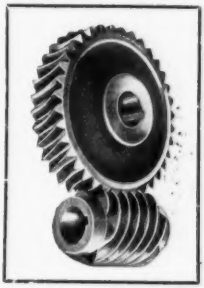

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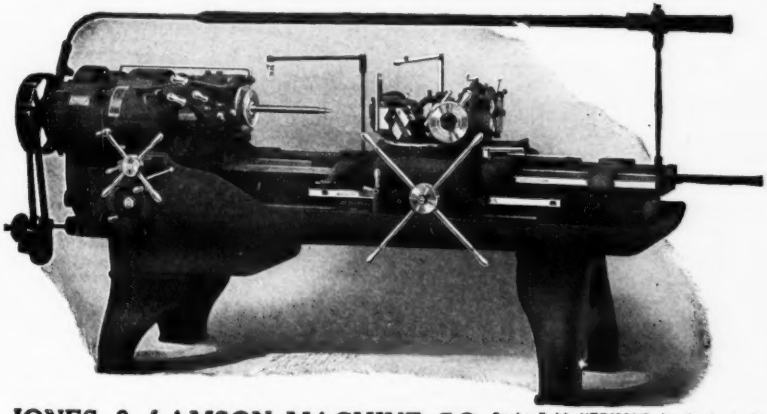

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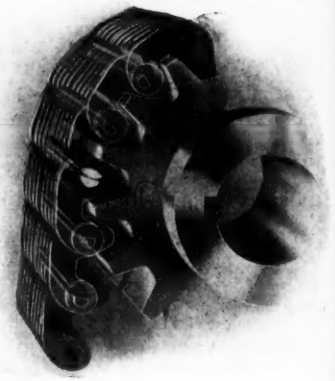

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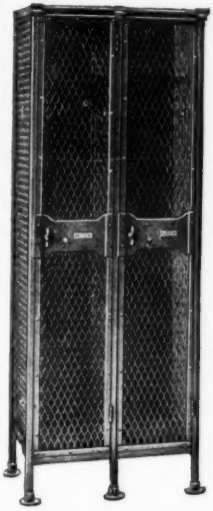

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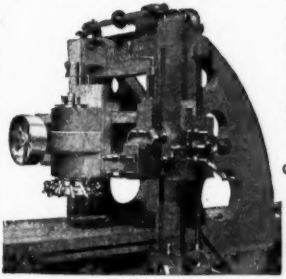

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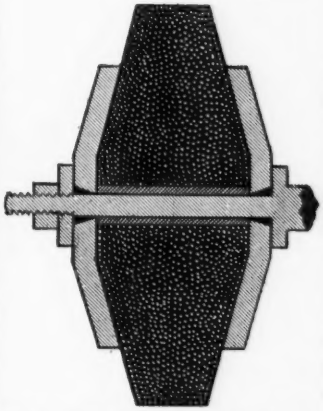

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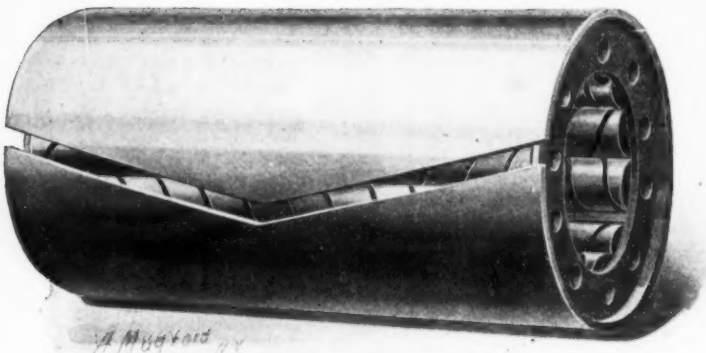

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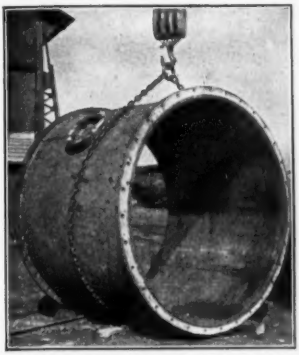

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PROFIT-MAKING MANAGEMENT is a concise expression of the methods which Mr. Carpenter has developed and which he constantly uses in his own practice. They have been tried and perfected under the stress of daily operation in the course of his experience as supervisor, manager, head of the labor department, and president, of various large manufacturing plants, notably the National Cash Register Company and the Herring-Hall-Marvin Safe Company, of which latter concern he is now chief executive.

The study of works-management methods will be found to be marked throughout by the clear sight, the fair mind, the direct dealing, and the strong vitality of the author. The whole treatment is vibrant with life, the work indeed having been produced amid the incessant and insistent claims of active work in the management of the great manufacturing company of which he is president and manager. It is inspired by his keen interest in the promotion of better ideals in industrial organization. It is largely a labor of love, freely devoted to the advance of the profession of industrial engineering. And it bears throughout the stamp of tried, practical success.

CONTENTS BY CHAPTERS

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IV. Designing and Drafting Department
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IX. Standard Times for Handling the Work
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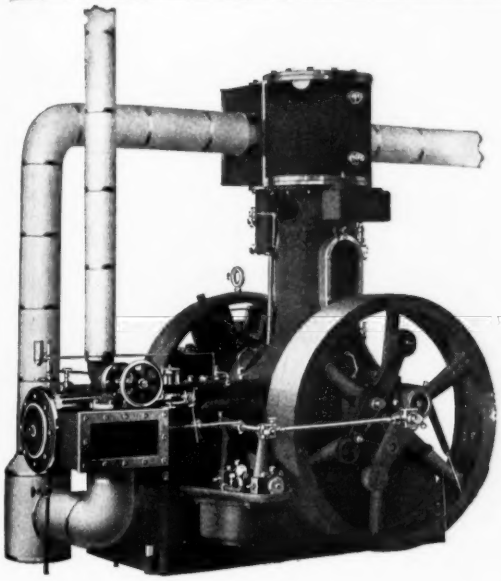

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The American-Ball Angle Compound

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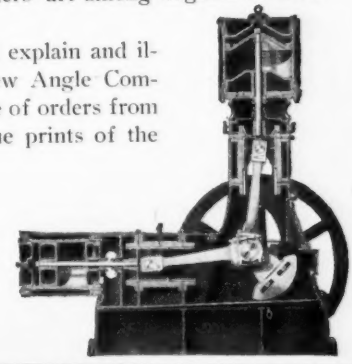

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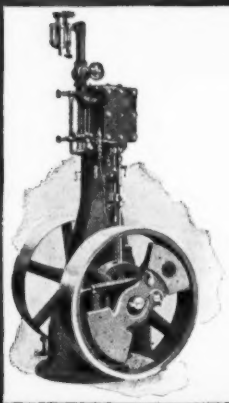

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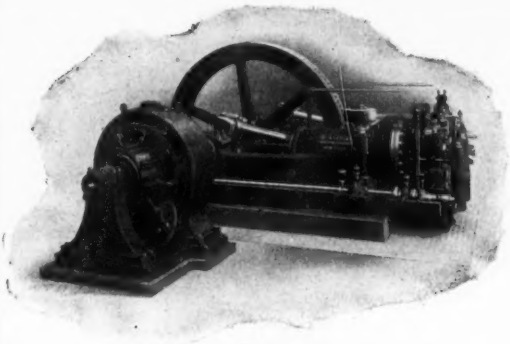

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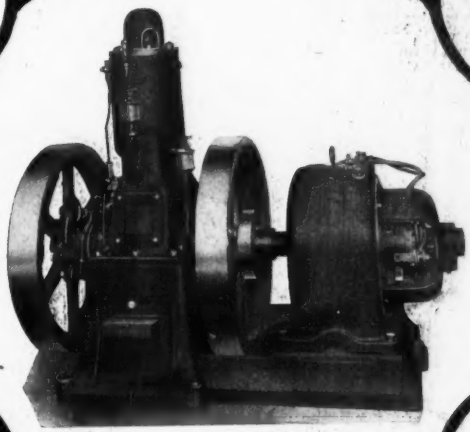

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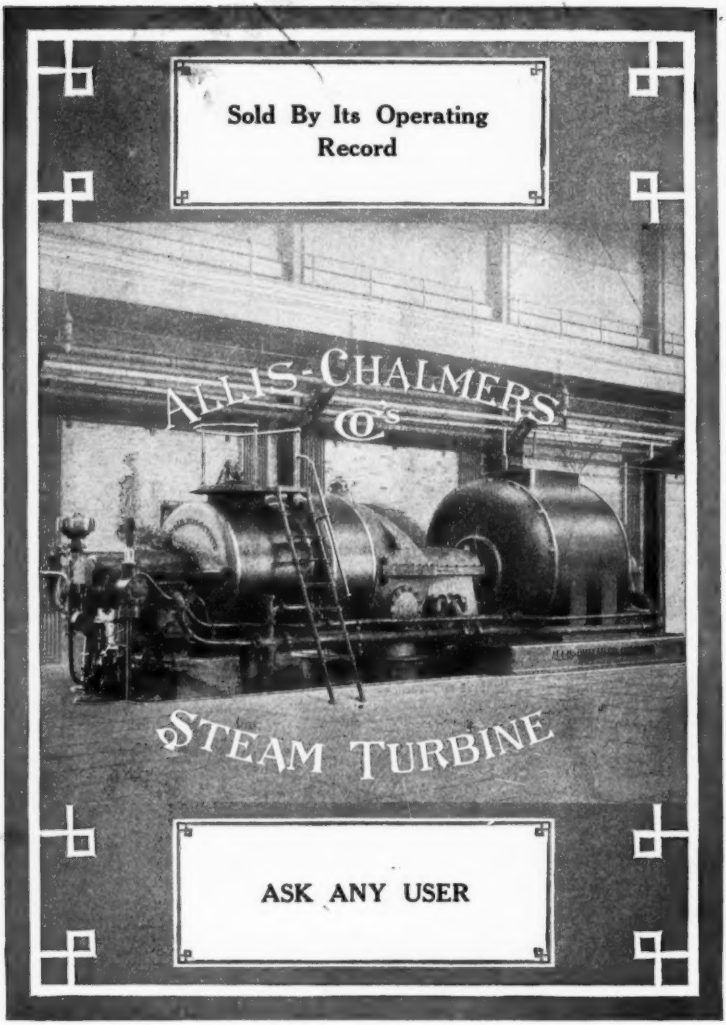
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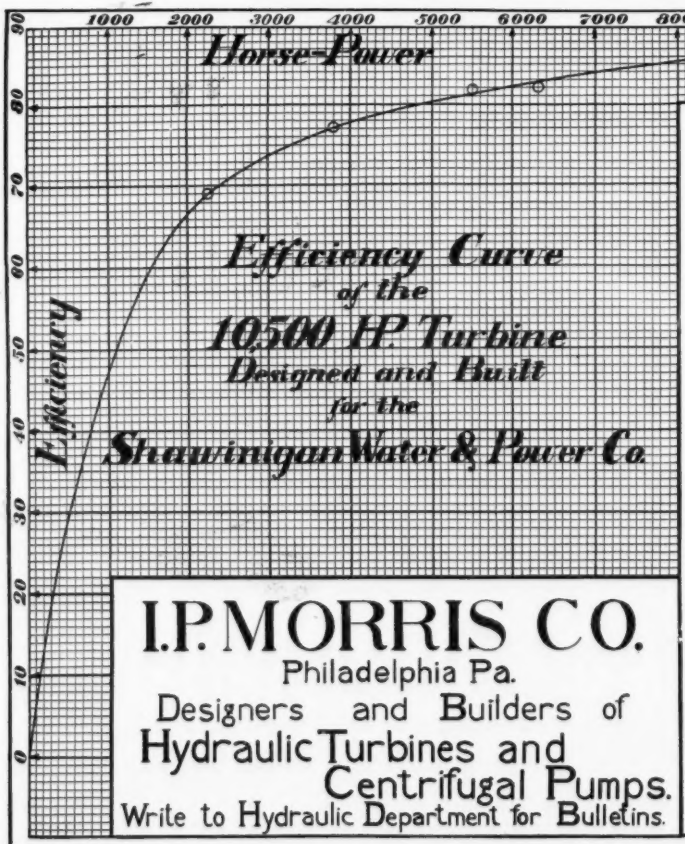
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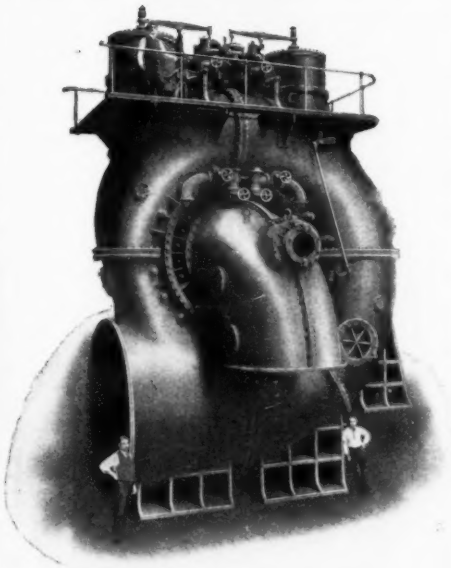

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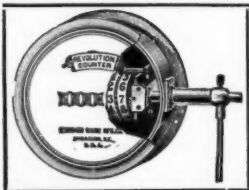

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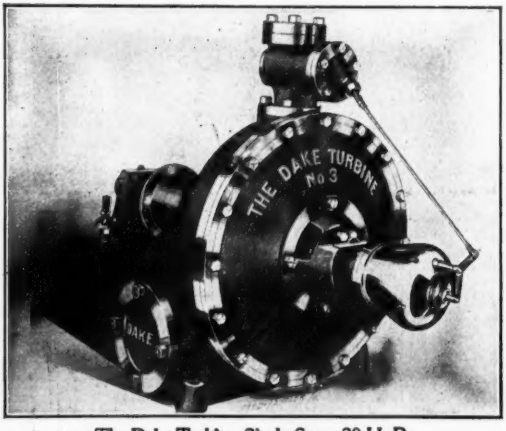

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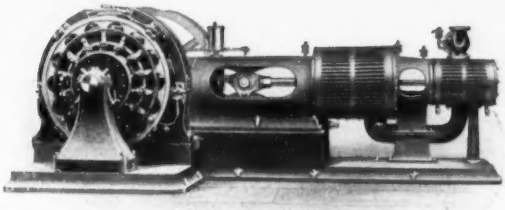

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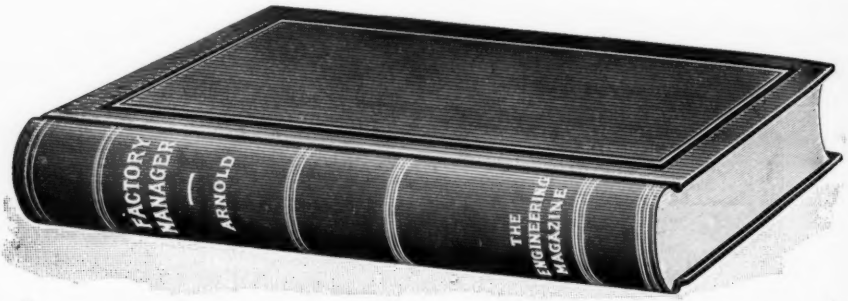

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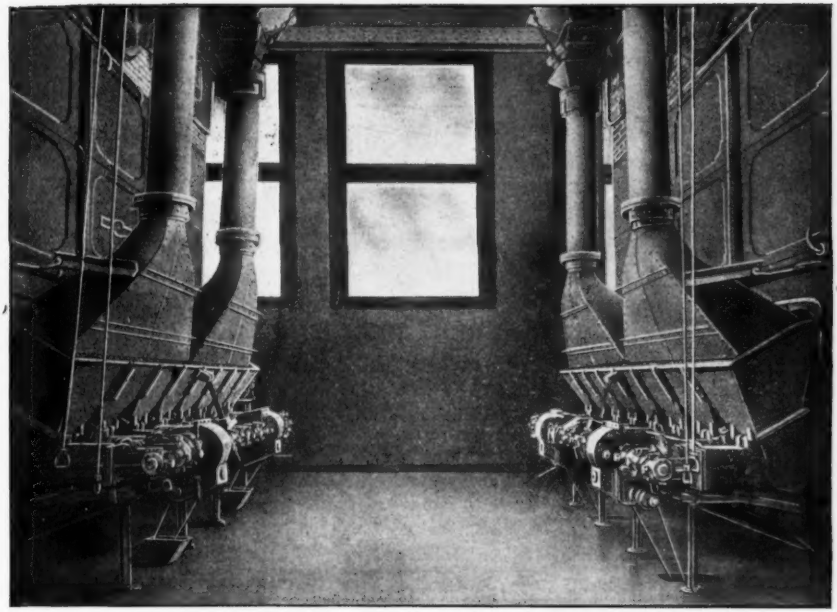

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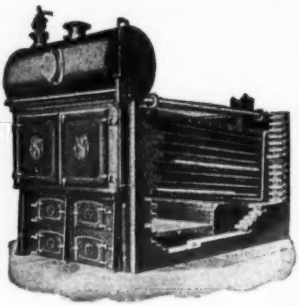

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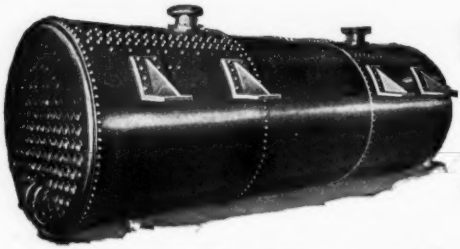

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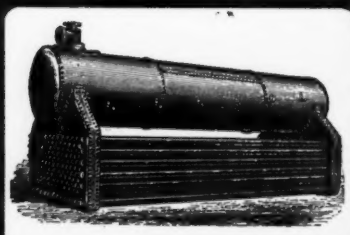

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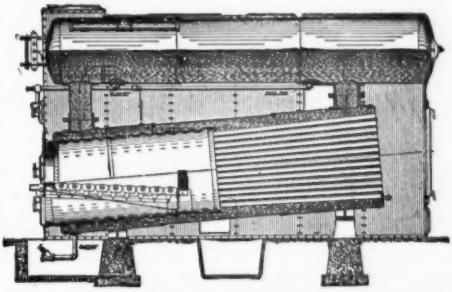

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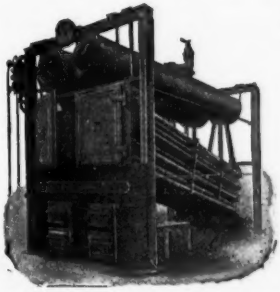

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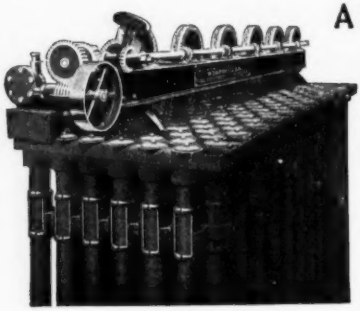

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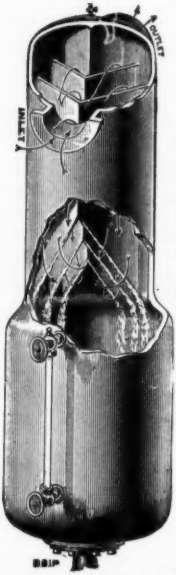

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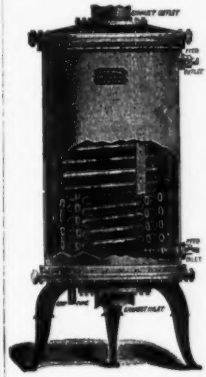

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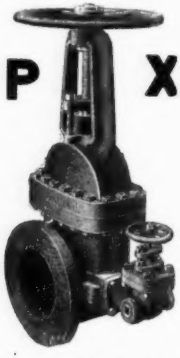

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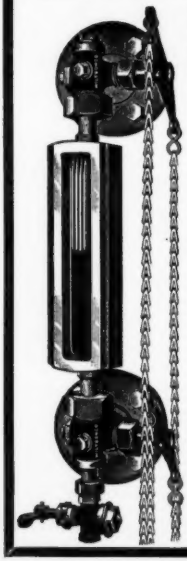

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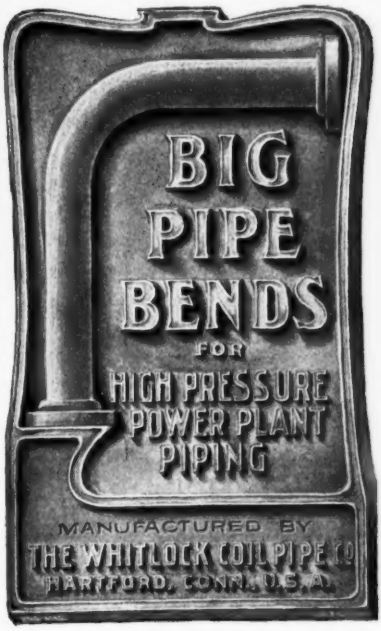

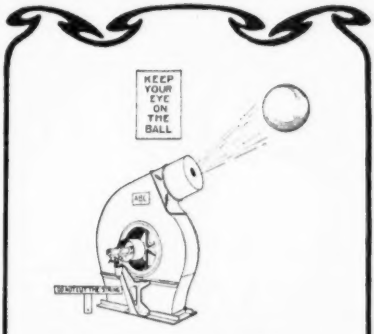

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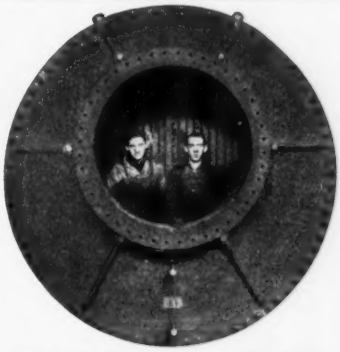

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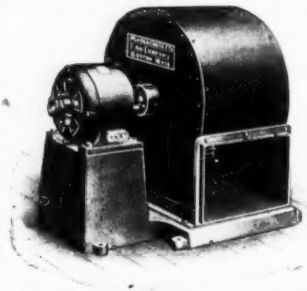

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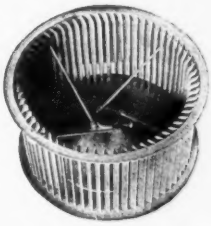

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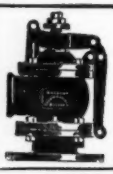

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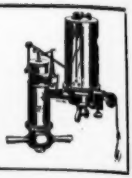

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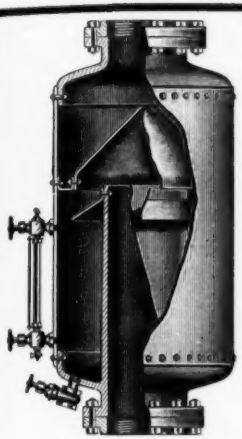

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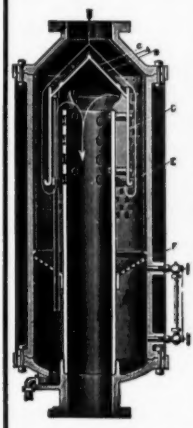

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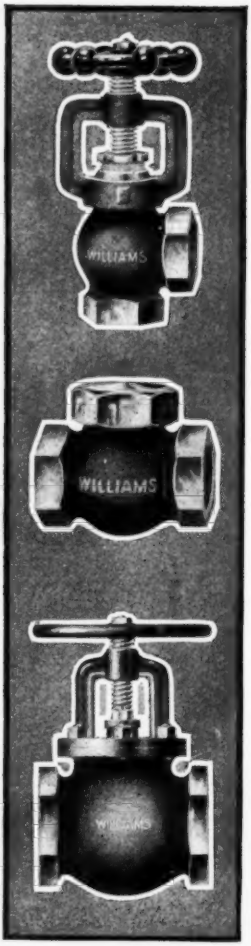

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WILLIAMS Valves are made in both Brass and Iron, in all styles and sizes, and for every purpose. When you need valves be sure and specify "WILLIAMS." This name is cast on everything we manufacture, and represents all that is good and up-to-date in modern engineering practice.

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should be in the hands of every user of steam specialties. It contains nearly 200 pages with 500 handsome illustrations showing our complete line and is full of valuable tables and useful engine room recipes. It is conceded to be one of the handsomest valve catalogs ever published. Just off the press. New, fresh and interesting. WE WANT YOU TO HAVE A COPY. Write us or your nearest dealer.

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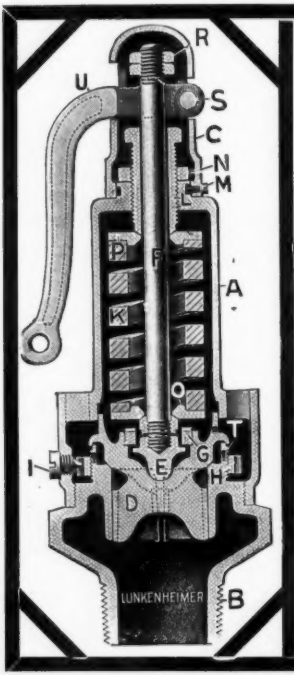

LUNKENHEIMER Brass "Pop" Safety VALVES

¶ Never fail to operate when the pressure in the boiler exceeds that for which the valves are set.

¶ They have full relieving capacities and can be set to relieve any quantity of steam. Do not chatter or pound.

Your local dealer should have them, if not write us.

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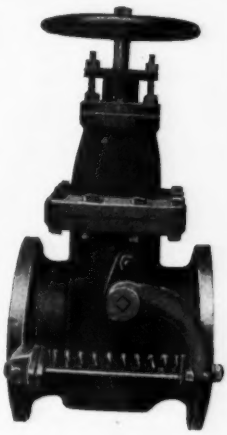
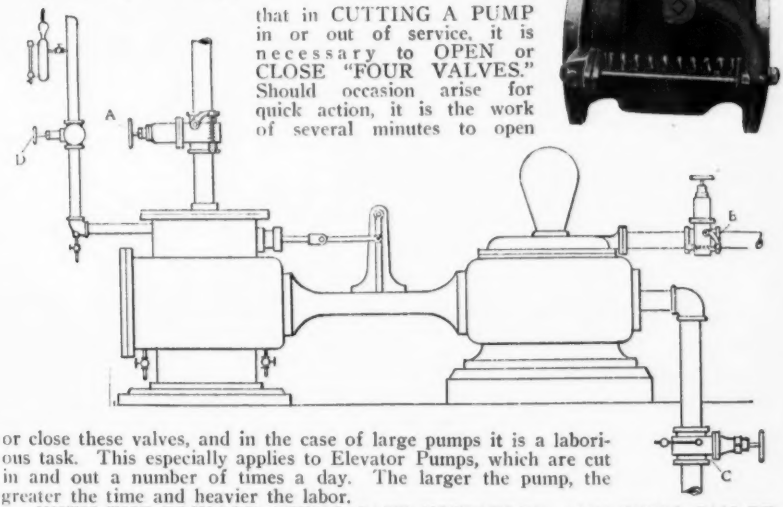
THE ERWOOD SWING GATE

FOR PUMP SERVICE



"Every Engineer Knows"



that in CUTTING A PUMP in or out of service, it is necessary to OPEN or CLOSE "FOUR VALVES." Should occasion arise for quick action, it is the work of several minutes to open or close these valves, and in the case of large pumps it is a laborious task. This especially applies to Elevator Pumps, which are cut in and out a number of times a day. The larger the pump, the greater the time and heavier the labor.

WITH THE ERWOOD SWING GATE INSTALLED, ANY PUMP CAN BE READILY CUT IN OR OUT BY SIMPLY OPERATING THE THROTTLE VALVE ABOVE. AS THE STEAM OPERATES OR STARTS THE PUMP, THE ERWOOD SWING GATE OPENS ACCORDINGLY.

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On EXHAUST LINES also of STEAM HAMMERS, STEAM ELEVATORS, AIR COMPRESSORS, etc., the ERWOOD VALVE SHOULD BE FITTED AND KEPT CLOSED, as these units can also be started or stopped by SIMPLY OPENING THE STEAM VALVE.

In this way, THE EXHAUST from one pump or engine CANNOT BACK UP or FILL OR WATERLOG THE CYLINDER of another when either running very slowly or stopped entirely. The ENTIRE EXHAUST STEAM consequently BECOMES AUTOMATIC, and where the operations are alternate, POSSIBLE LOSS OF LIVE STEAM AND EXHAUST, which would result from the exhaust steam backing up into the standing cylinder and either filling the cylinder with condensation or wasting through the drips, IS ENTIRELY AVOIDED.

In the above sketch (*A*) represents an Erwood Valve doing Back Pressure service and (*B*) is an Erwood acting as a Combined Check and Gate. (*C*) is an Erwood as a Self-cleaning Foot Valve, (*D*) a common globe valve for throttle service.

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The POWELL
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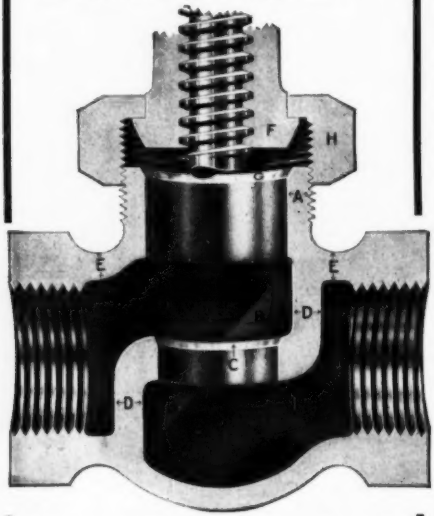
VALVE

Is constructed on exact scientific principles



¶ Every one of the points lettered in the illustration has been carefully studied so as to supply a valve that will meet every condition that is presented.

¶ We have a pamphlet that describes this illustration in detail. We would like to send YOU a copy—a postal card request is sufficient.

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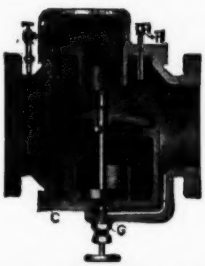

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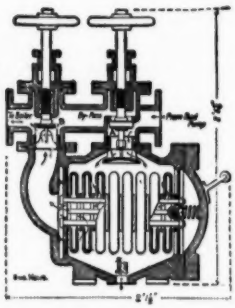

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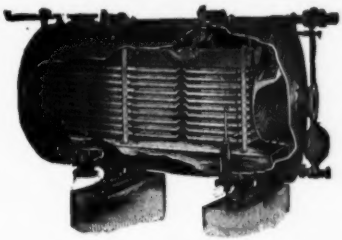

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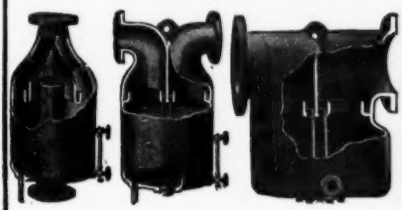

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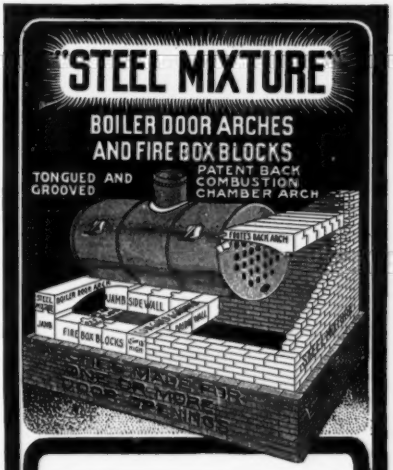

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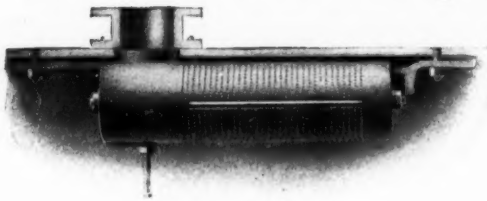

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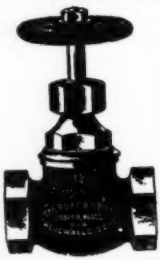

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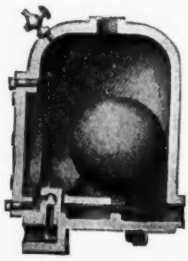

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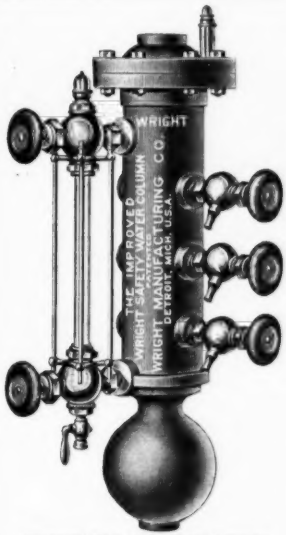

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The whistle shrieks when the water level approaches the danger line.

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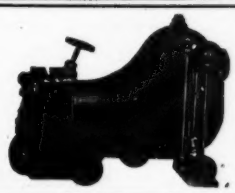

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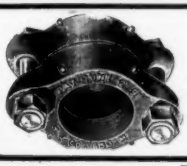

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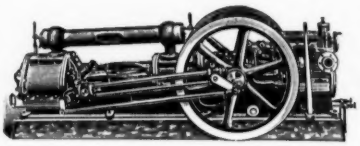

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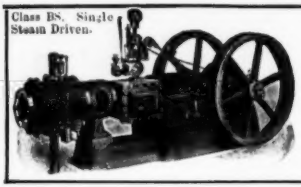

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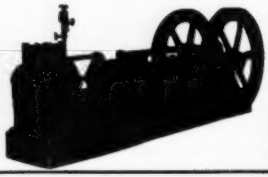

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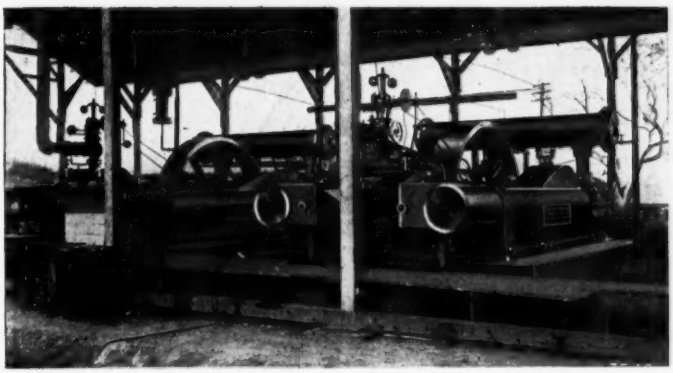

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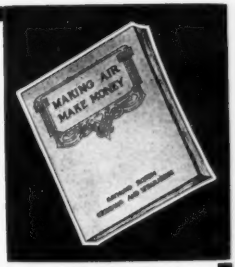

We may not be able to do as much as that for you, but if you *grind to powder* in your factory or mill *any material*, it is probable that we can show you under our methods a substantial saving. You may not realize, may never have figured, how much you could save if you eliminated all the waste of material in your grinding process, if you were to produce *finer* powder, if you were to dispense with extra auxiliary machinery, if you did away with all bolters and screens, which are not only expensive under first cost but are costly to maintain, replace and keep in repair, to say nothing of cost of extra and under our system, unnecessary labor. We have successfully solved the pulverizing problem for more than two hundred of the largest concerns in the world.

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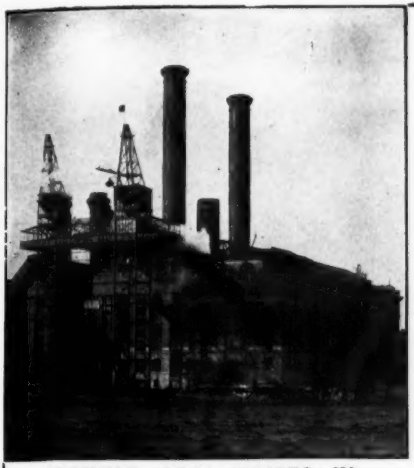

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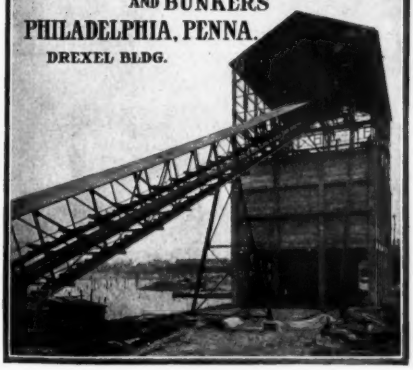

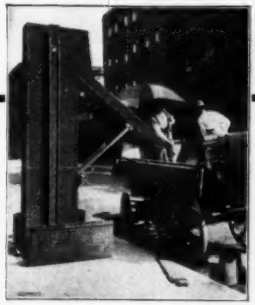

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Coal and Ashes Handling Systems for Power Plants
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THE BUSY ENGINEER
will save time by reading the
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The Koppel system is a railway made to order.

We are engineers, as well as manufacturers.

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The Koppel Portable Track

Can be laid quickly and easily anywhere. Requires no special roadbed. Makes a solid, substantial railway. Is economical, efficient and capable of withstanding the hardest kind of service.

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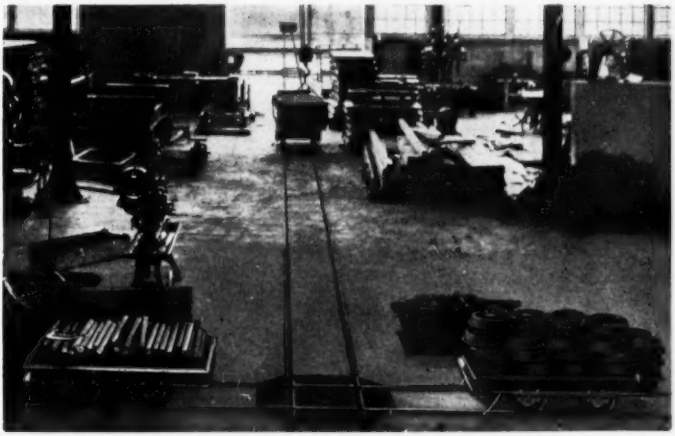

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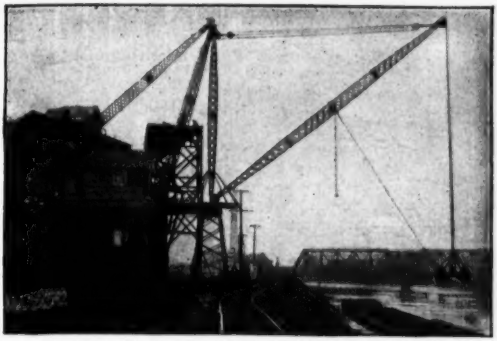

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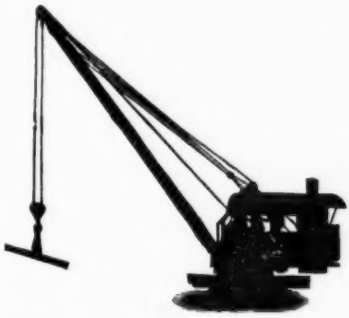

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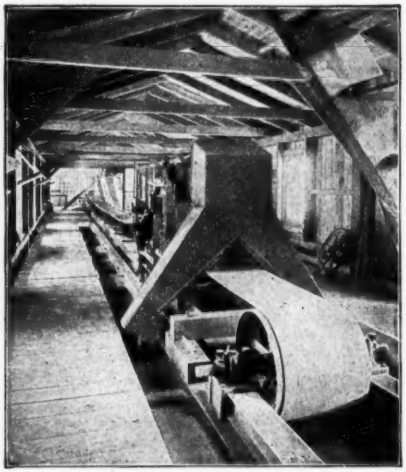

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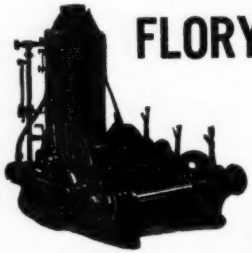

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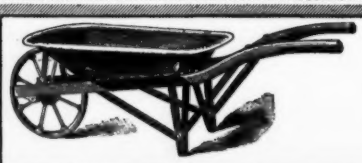

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Special Barrows made to order
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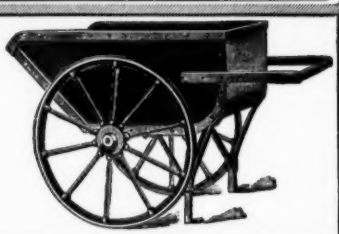

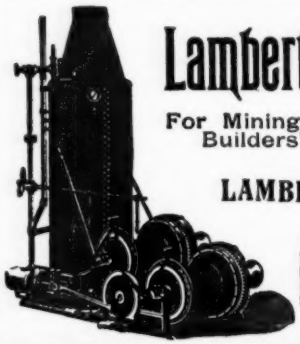

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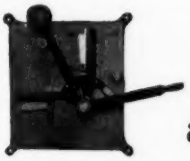
Leading articles from leading engineering journals record progress in Motor Vehicles. See the Engineering Index in this magazine. . . . . . .



Float Switch used with Self-Starter

Automatic Starting Devices and Remote Control of Electric Motors

Gauge-Type Pressure Regulator

TO USERS of electric power few devices employed in connection with motors are so interesting as the "self starter." The construction and operation of the solenoid which is a characteristic feature of these automatic motor starters are doubtless familiar to most readers of this advertisement, but unless one has been able to keep in close touch with the development of electrical apparatus in recent years, he is likely to be astonished at the results accomplished by this little coil of wire, which, when energized by the passage of current through it, sucks up its plunger (or core), thus closing the circuit to the motor.

Oil-Immersed Self-Starter

In some plants automatic motor starters are installed solely for the purpose of preventing careless employes from starting up the motors too suddenly, but the value of the self-starter consists chiefly in the fact that, when combined with suitable energizing devices, such as float switches, pressure regulators, limit switches, or even a push-button switch, it dispenses altogether with the need of employing someone to start and stop the motor at the proper time, or else enables the one charged with this duty to control the motor from a distance.

Self-Starter for D. C. Motor

A good example of the advantage of remote control is found in mining work, where (in mines employing manually operated starting boxes) it is oftentimes necessary to send a man down the shaft to start a motor. In mines where self-starters are installed every motor can be controlled by switches located in the power house or at any other convenient point.

In connection with electrically operated elevators, hoists, etc., the self-starter insures a smooth start and gradual acceleration to full speed, since, by means of dash-pot the starting period is predetermined and is not affected by carelessness on the part of the operator.

In connection with motor-driven pumps and air compressors, the self-starter finds one of its widest fields of usefulness. By means of a switch operated by a copper float in the tank the circuit to the motor is automatically opened and closed through the self-starter whenever the water in the tank reaches a predetermined high or low level. The same device may be used in sump pits, or, indeed, wherever there is sufficient change in water level to operate a float switch.

Self-Starter for A. C. Motor

In compression tank systems, and when used with air compressors, a pressure gauge is substituted for the float switch, the circuit being made and broken as the needle, or indicator, moves back and forth between two fixed points.

We have been designing and constructing electric controlling devices for the past 17 years, and shall be glad to send you, on request, Bulletins descriptive of self-starters, or any of our other lines of manufacture, such as motor speed regulators, machine-tool controllers, elevator controllers, crane controllers, etc.

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MILWAUKEE, WISCONSIN.

New York Office, 136 Liberty St.
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Please mention The Engineering Magazine when you write.

TYPE "G" CONTROLLERS

for the control of motors of 1 to 50 H. P.

Coil or Cast Grid Resistance

All parts are of easy access and interchangeable

SMALL—COMPACT—DURABLE

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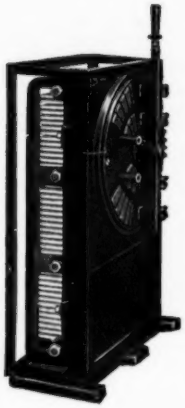


The Electric Controller & Supply Co.

Cleveland, Ohio.

INCREASE THE PRODUCTION OF YOUR OLD TOOLS

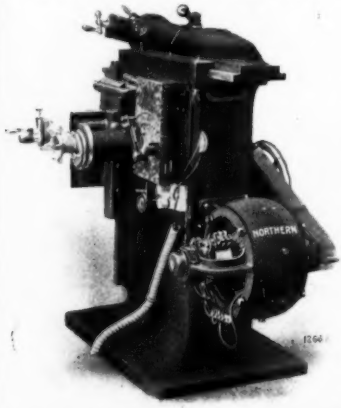
BY THE APPLICATION OF NORTHERN MOTORS

Northern Constant Speed and adjustable speed motors can be applied to old tools as well as new. An old tool properly equipped with motor drive is capable of marked increase in production, in many cases showing as high as 75%.

A direct connected motor renders the tool self-contained and permits it being placed in a manner allowing the material being worked to be handled to best advantage.

For extensions of shop equipments or rearrangement of old equipments, individual motor drive is particularly advantageous.

The history of Northern variable speed motor drive is the history of successful motors and motor applications—our engineers have made a special study of equipping old tools with motor drive—write us about a few of your old tools and we will tell you how to increase their output and cut your labor costs.



The 16-inch Garvan Shaper illustrated was converted from belt drive by mounting a Northern 1½ H.P. type "B" form R motor on the rear of the housing and connecting by silent chain. The large sprocket was provided with hand wheel for adjusting the tool. The speed range as a belted tool was from 90 revolutions to 167 revolutions in four equal steps. Using a 4 to 1 adjustable speed motor and a 15 step controller the range is from 80 to 320 R.P.M. with 15 intermediate speeds.

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Standard and Special Electrical Machinery

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By A. H. BARKER

Cloth, - - $3.

THE ENGINEERING MAGAZINE
140 Nassau Street, " " New York

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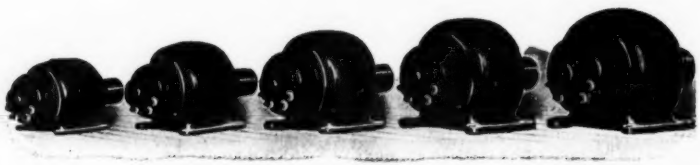

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See Bulletin 78 N.

is made when individual motors are installed by EXPERTS in a factory that has been driven in the old-fashioned way.

Motor-drive has been our most important specialty since 1888.

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Are sold under **THE BROADEST GUARANTEES** as to Overload Capacity and Low Temperature Rise ever made by any Company.
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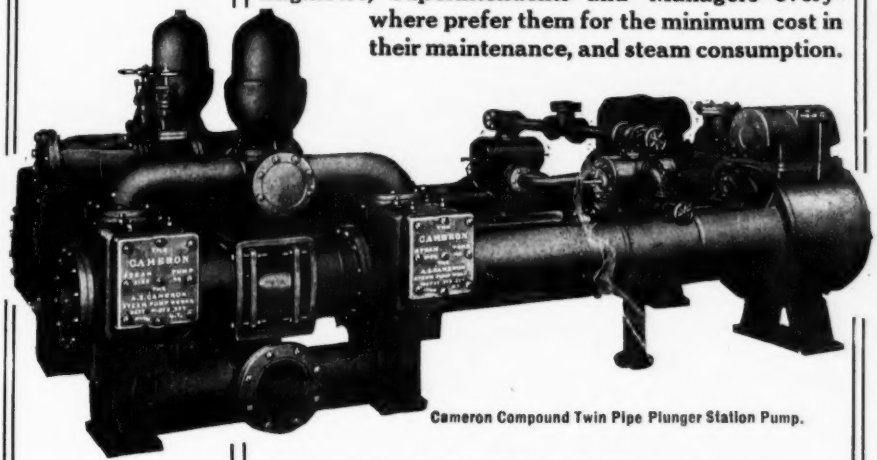

Cameron Compound Twin Pipe Plunger Station Pump.

We court the most searching investigation and closest examination. We will send our catalog "X" on request, or will be pleased to confer with you in person or through our nearest agent regarding CAMERON PUMPS.

This type, like all CAMERON PUMPS, may be run at a very low or a very high rate of speed, reducing the capacity to the minimum requirements or trebling its capacity in an emergency or when necessary, without appreciable damage to working parts.

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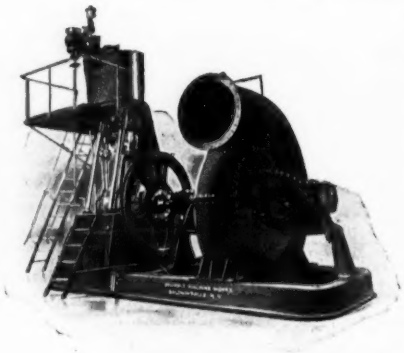
FOR ALL PURPOSES

Circulating, Dredging and Wrecking



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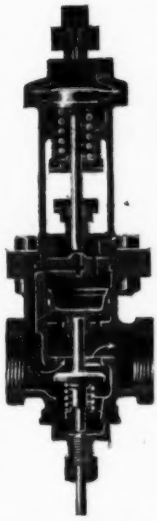

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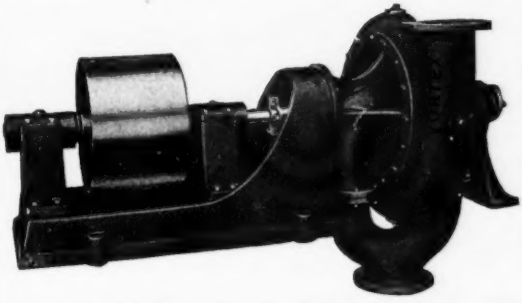

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THERE are so many places where the Vortex High Efficiency Centrifugal Pumps are most desirable that you should not fail to place your pump requirements before us.

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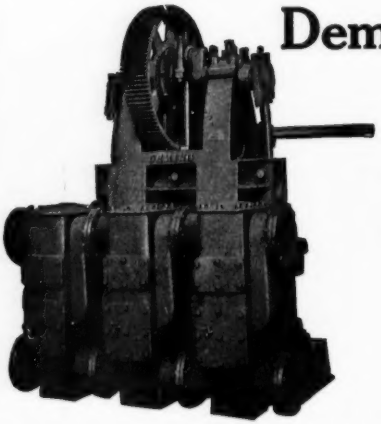

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The Acme of Efficiency

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Triplex Pump for boiler feed and general service. Deep Well Pumps for pure water supply.

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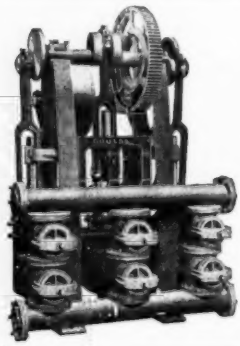

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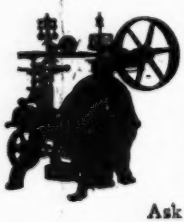

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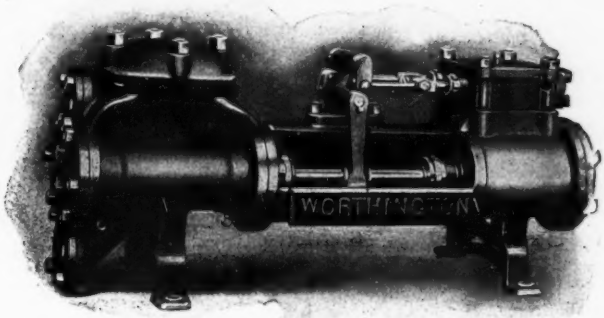

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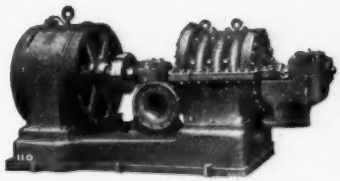

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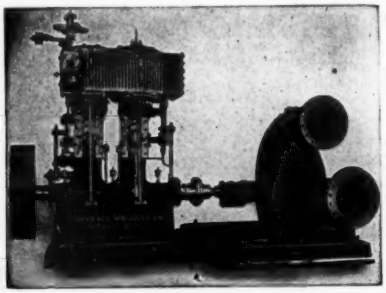

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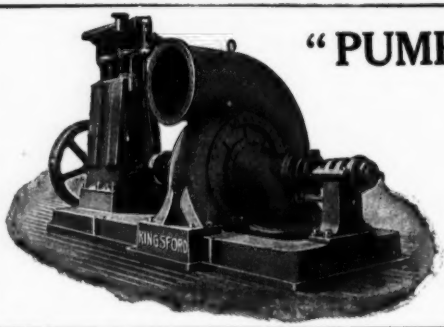

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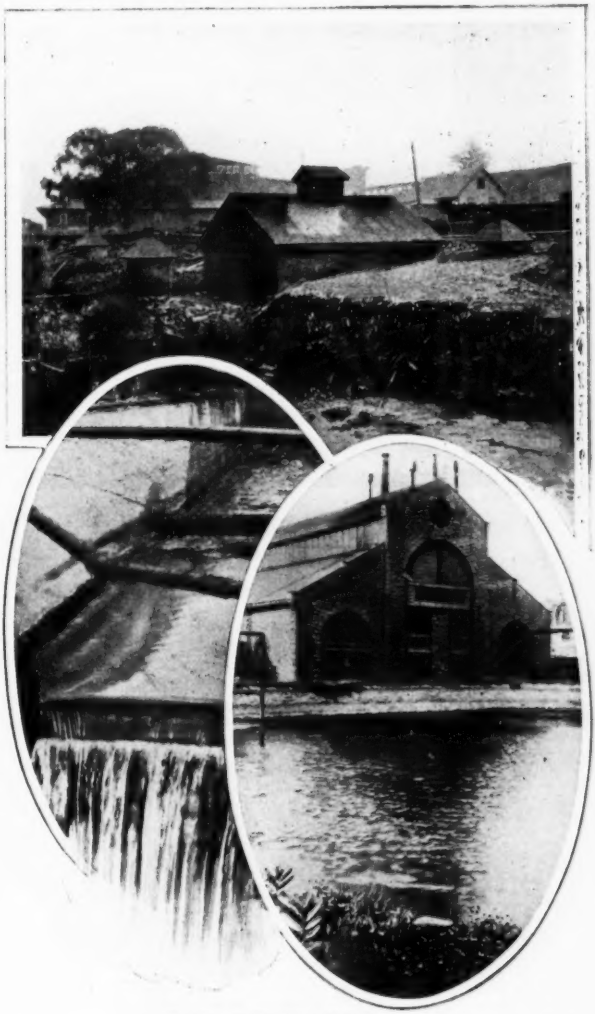

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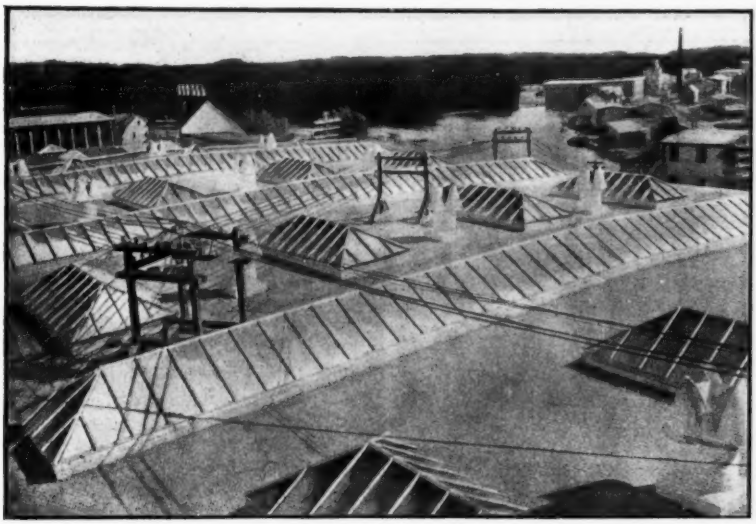

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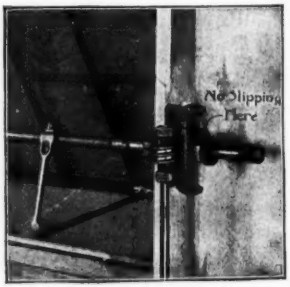

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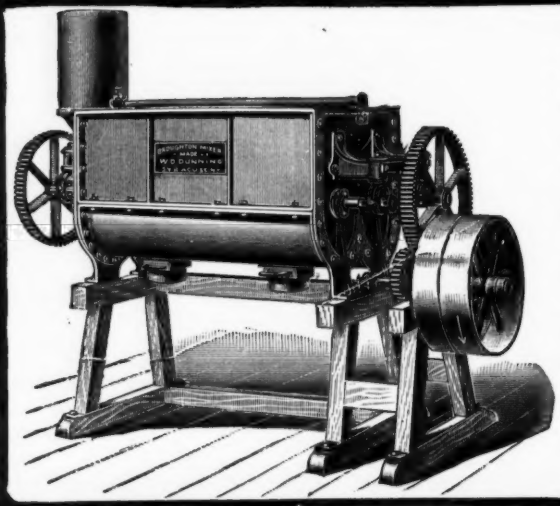

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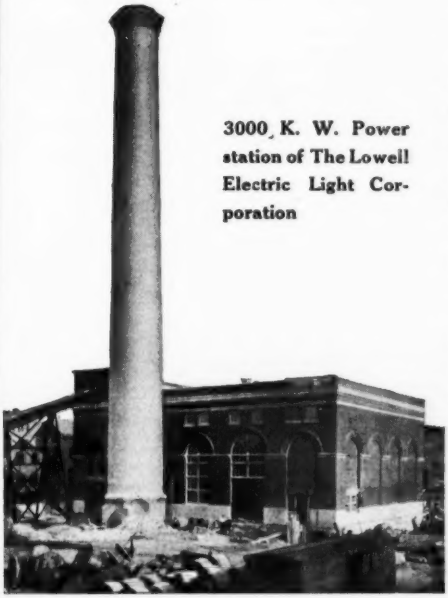

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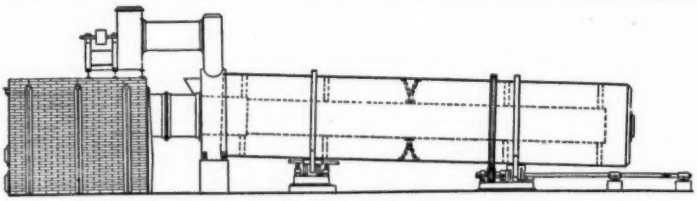

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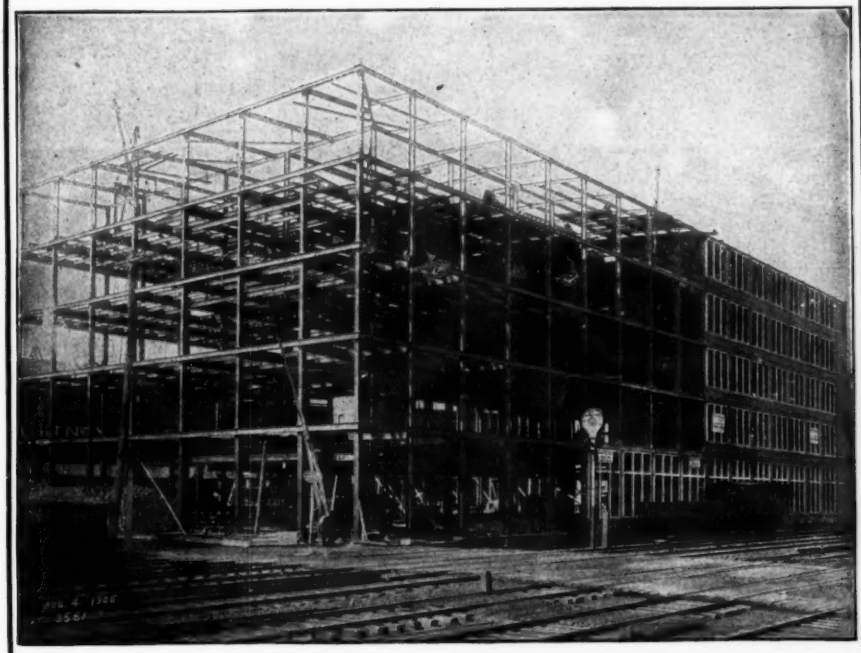

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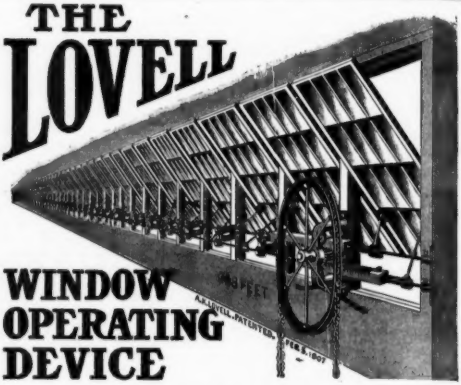

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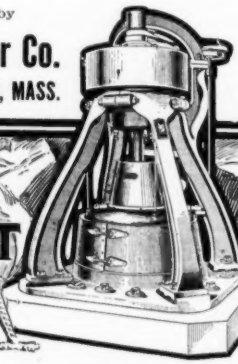

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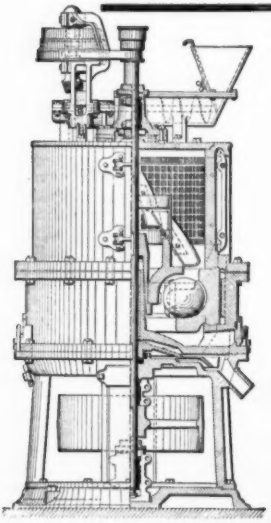

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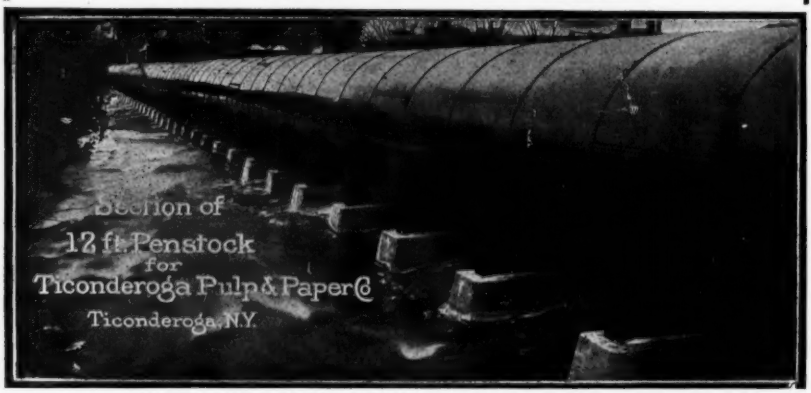

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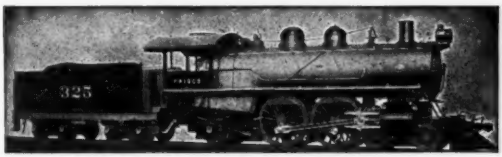

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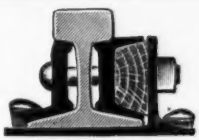

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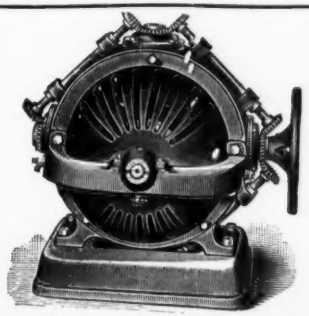

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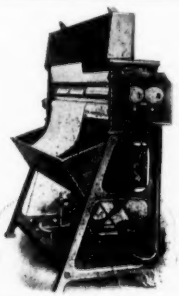

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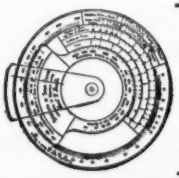

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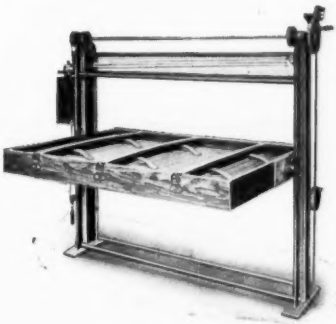

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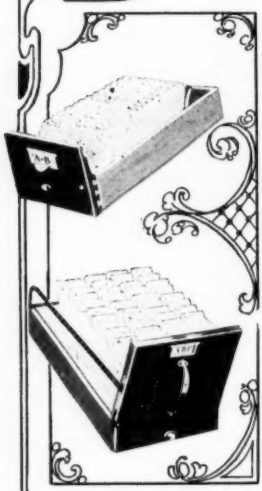

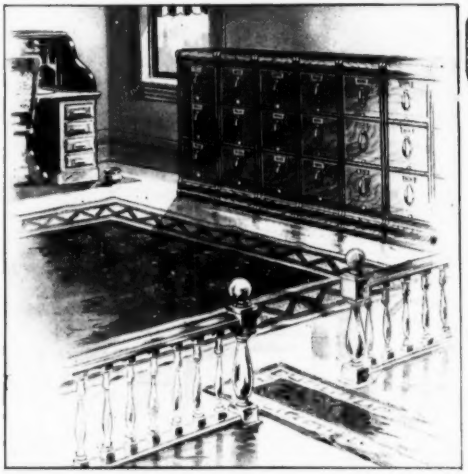

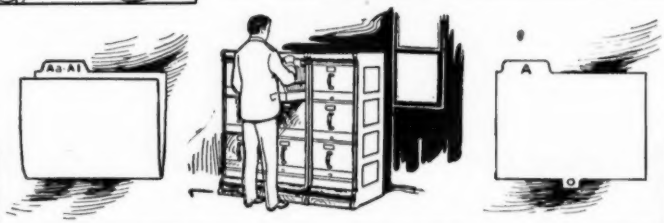

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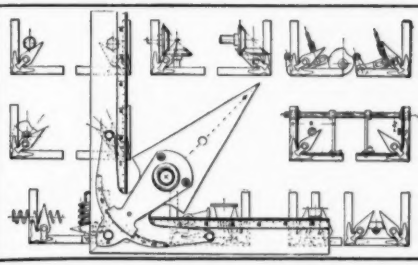

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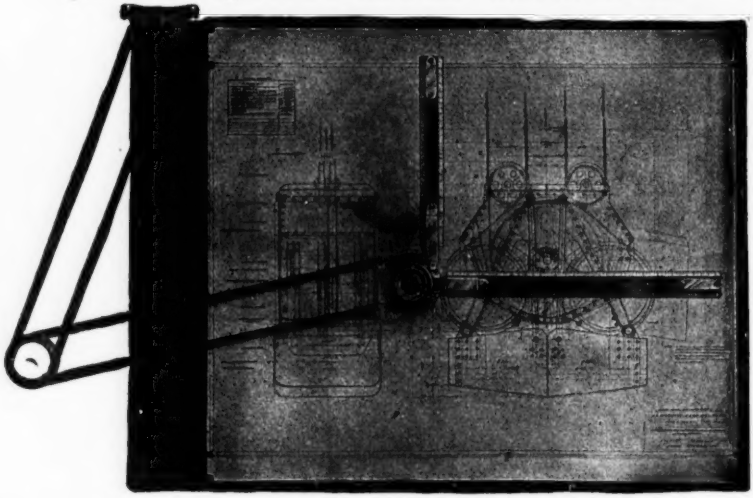

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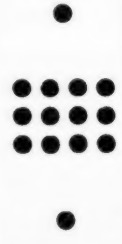

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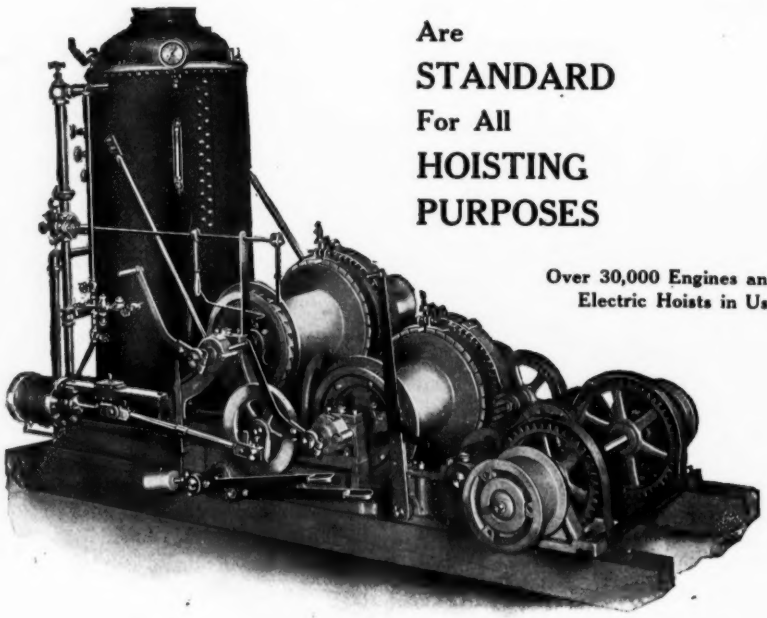

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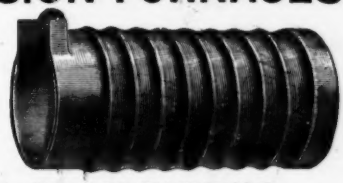

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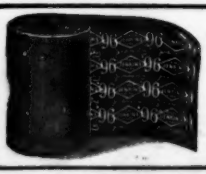

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